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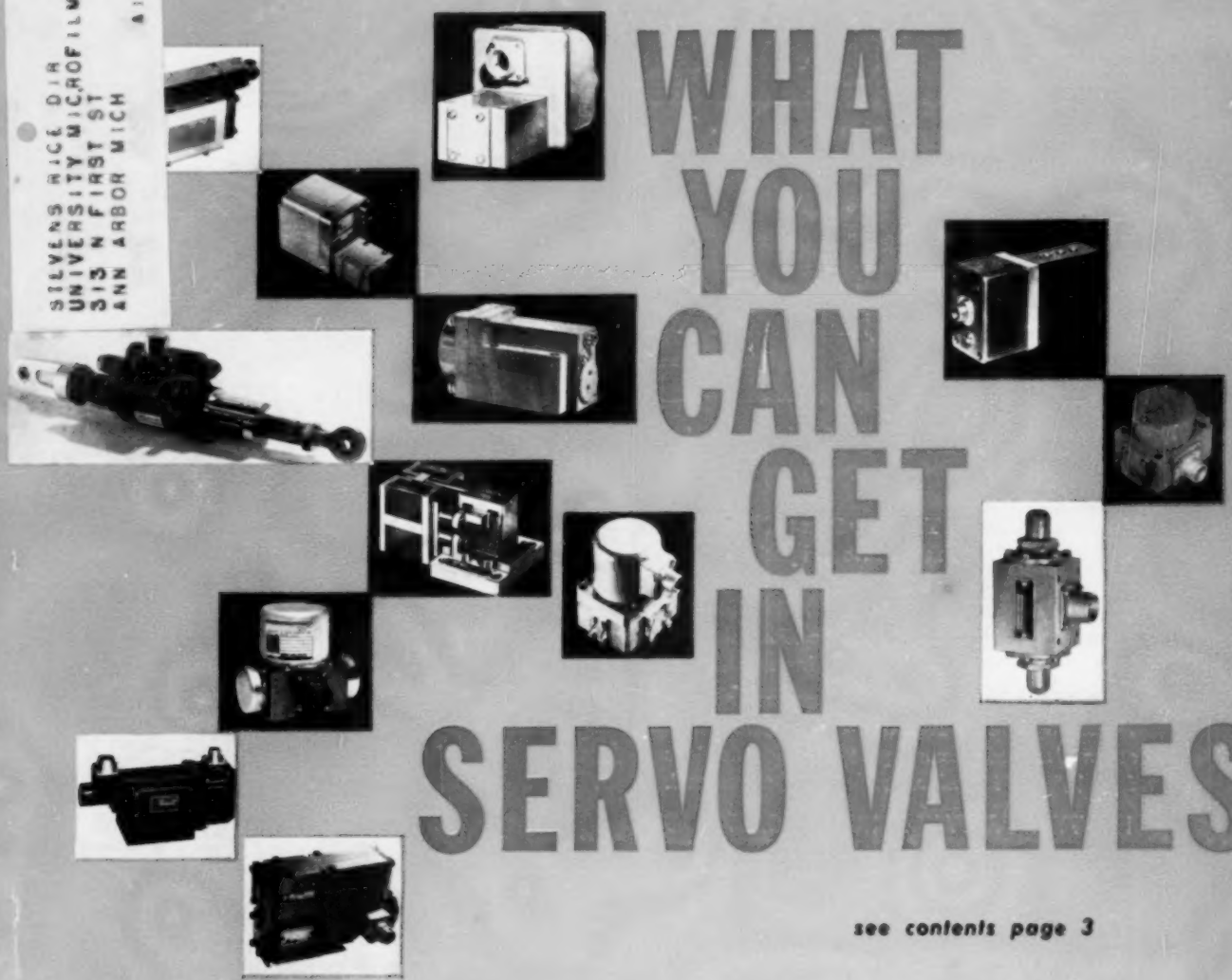

WHAT YOU CAN GET IN SERVO VALVES

see contents page 3

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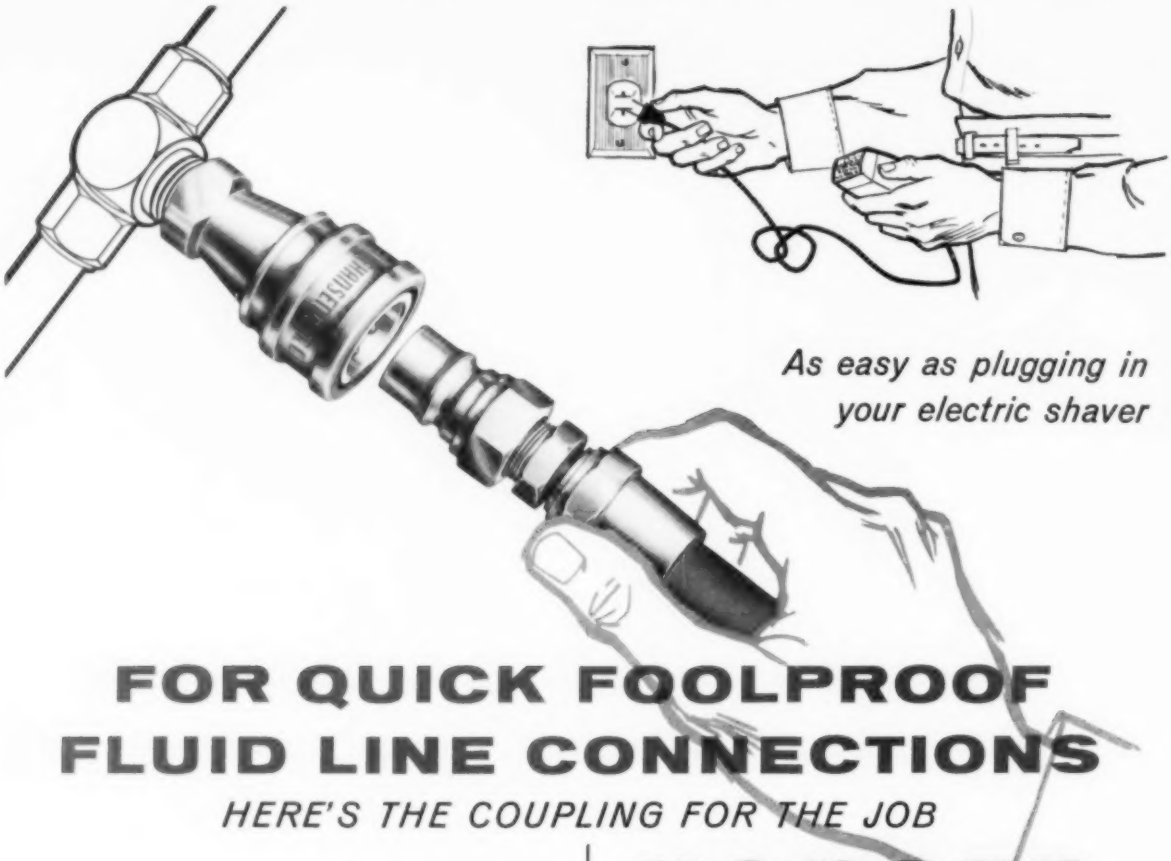

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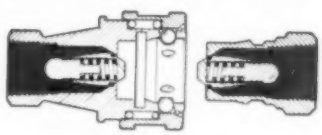

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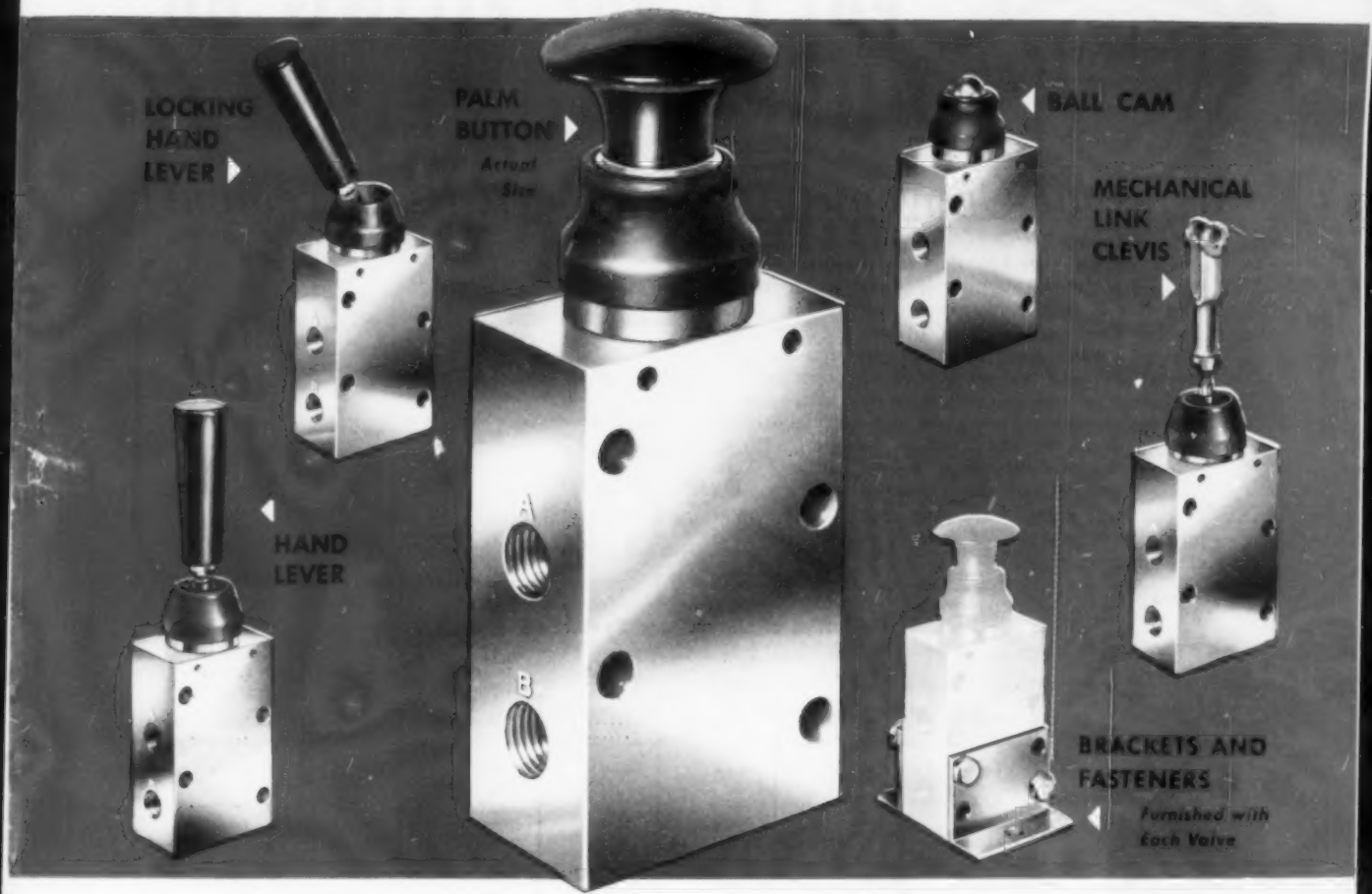


Hanna Flo-Pilot Valves are ¼" two- and three-way Pilot Valves for air operation to 150 psi. They are used for remote control of master valves, directional control of small single acting cylinders and for shut-off. Same valve can be used for two or three-way operation either normally open or normally closed to inlet pressure.

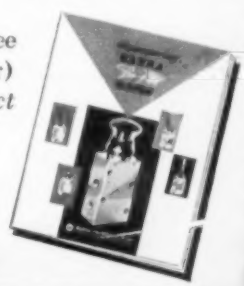
HANNA Flo-Pilot Valves will deliver years of dependable performance at a very low cost because they have built-in money-saving features. Every Hanna Flo-Pilot Valve is equipped with a synthetic boot which seals the valve stem and internal parts from harmful dirt and abrasive, thereby eliminating the most common cause of valve failure.

These protective boots, efficient "O" ring spool packing and nylon sleeves, are built into every Hanna Flo-Pilot Valve to save you money and assure leak-free operation even after millions of cycles.

The five actuating-heads—push button, ball cam, hand lever, locking hand lever and mechanical link clevis—are interchangeable in a matter of seconds. Spools can be changed just as quickly without disturbing the piping.

Corrosion resistant materials are used throughout. Flo-Pilot Valves have a simple, sturdy construction with anodized aluminum body, stainless steel and molded nylon parts. Valves can be conveniently mounted in any position and are furnished with brackets and fasteners. They are easy to operate, positive acting and have full capacity of ¼" orifices.

Ask your Hanna representative (see the yellow pages or Thomas Register) for complete information or *write direct for Catalog 262.*



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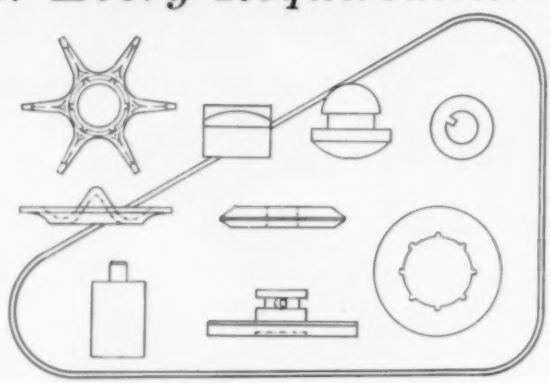

Relative Properties of Natural and Synthetic Rubber

Property ASTM ABBR.	Natural Rubber (NR)	GR-S Buna S (SBR)	Butyl (IIR)	Thiokol	Nitrate (Buna N) (NBR)	Neoprene (CR)	Silicone
Tensile Strength (psi)							
Pure Gum	Over 3000	Below 1000	Over 1500	.....	Below 1000	Over 3000	Below 1500
Black Load Stocks	Over 3000	Over 2000	Over 2000	.....	Over 2000	Over 3000	.....
Hardness Range (Shore Duro A)	30-90	40-90	40-75	35-80	40-95	40-95	40-85
Specific Gravity (Base Material)	0.93	0.94	0.92	1.34	1.00	1.23	.....
Tear Resistance	Good	Fair	Good	Poor	Fair	Good	Poor
Abrasion Resistance	Excellent	Good to excellent	Good	Poor	Good	Excellent	Poor
Solvent Resistance							
Aliphatic hydrocarbons	Poor	Poor	Poor	Excellent	Excellent	Good	Poor
Aromatic hydrocarbons	Poor	Poor	Poor	Good	Good	Fair	Poor
Acid Resistance							
Dilute	Fair to good	Fair to good	Excellent	Fair	Good	Excellent	Excellent
Concentrated	Fair to good	Fair to good	Excellent	Fair	Good	Good	Fair
Oxygenated solvents (ketones, etc.)	Good	Good	Good	Good	Poor	Poor	Fair
Permeability to Gasses	Fair	Fair	Very low	Low	Fair	Low	Fair
Oil and Gasoline Resistance	Poor	Poor	Poor	Excellent	Excellent	Good	Fair
Animal and Vegetable-Oil Resistance	Poor to good	Poor to good	Excellent	Excellent	Excellent	Good	Fair
Oxidation	Good	Good	Excellent	Good	Good	Excellent	Excellent
Sunlight Aging	Poor	Poor	Very good	Good	Poor	Very good	Excellent
Heat Aging	Good	Very good	Excellent	Fair	Excellent	Excellent	Outstanding
Resistance to Swelling in Lubricating Oil	Poor	Poor	Poor	Excellent	Very good	Good	Fair
Resistance to Water Absorption	Very good	Good to very good	Very Good	Fair	Fair to good	Good	Good
Resistance to Lacquer Solvents	Poor	Poor	Poor	Good	Fair	Poor	Poor
Flame Resistance	Poor	Poor	Poor	Poor	Poor	Good	Fair
Cold Resistance	Excellent	Excellent	Good	Fair	Good	Good	Excellent
Heat Resistance	Good	Excellent	Excellent	Poor	Excellent	Excellent	Excellent
Ozone Resistance	Fair	Fair	Excellent	Excellent	Fair	Excellent	Excellent
Dielectric Strength	Excellent	Excellent	Excellent	Fair	Poor	Good	Good
Electrical Insulation	Good to excellent	Good to excellent	Good to Excellent	Fair to good	Poor	Fair to good	Excellent
Compression Set	Good	Good	Fair	Poor	Good	Fair to good	Fair

FOR MORE INFORMATION . . . **WRITE**

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VOLUME 12/NUMBER 2

FEBRUARY 1959

THE MAGAZINE OF FLUID POWER

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W-9000

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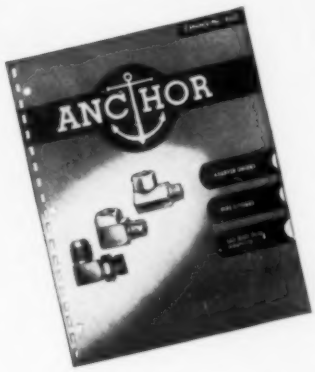

The new edition of Anchor's Catalog, covering the complete and enlarged line of unions, fittings and adapters, is just off the press and now available on request.

The Catalog contains a great deal of engineering data that will prove helpful to the engineer in planning his hydraulic connections.

The Anchor Line of Adapter Unions, Tees and Crosses is now even more complete in range of sizes and styles of fittings. Designed for use with Pressed-On and Reusable Coupling Hose Assemblies, they provide a ground joint, leakproof connection, and eliminate one or more pipe thread joints. Assembly, especially in confined quarters, is made easier and twisting and straining of the hose during assembly is prevented.

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IT'S HERE—

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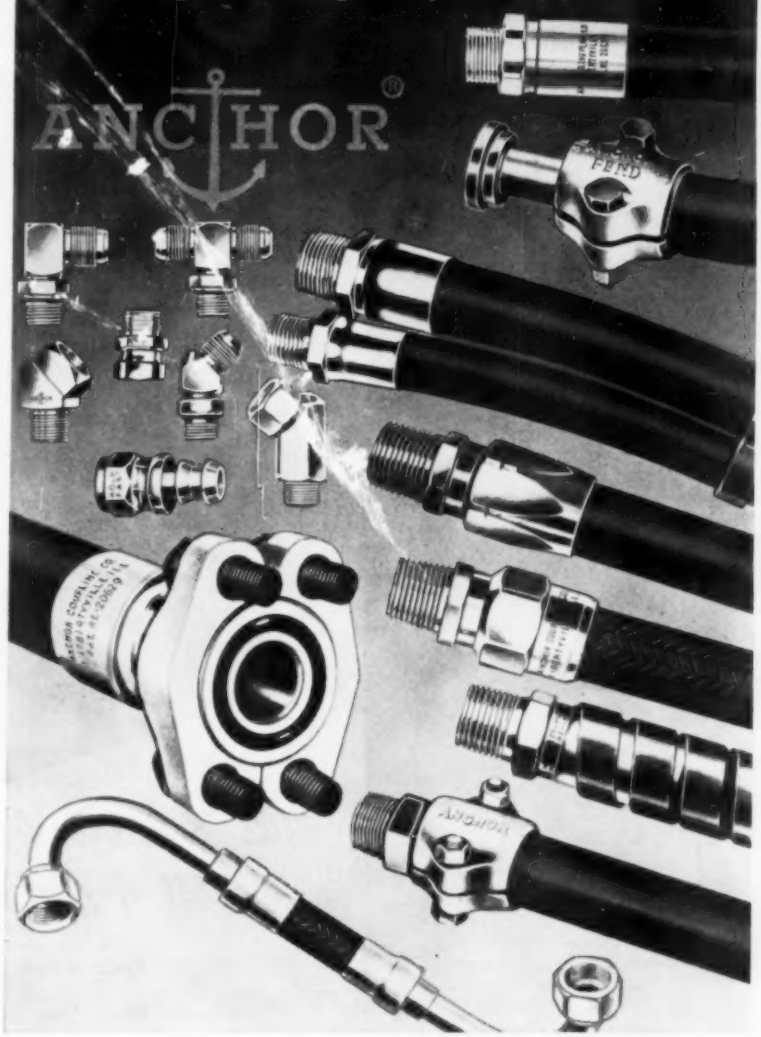

Write For Anchor Catalog No. 57S

When you have a problem in fluid power transmission, it's a safe bet that you can find its solution in an Anchor catalog. If not there, consultation with Anchor's engineers, with all their years of hydraulic experience, will be sure to bring the right answer.

We cannot say that the Anchor Line of hose assemblies, couplings and fittings is complete because it never will be. But we like to boast that if Anchor doesn't make it, it isn't being made!

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. . . Fluid Power news

REPORT NO. 11,704

Power and Control for New Lock Gates

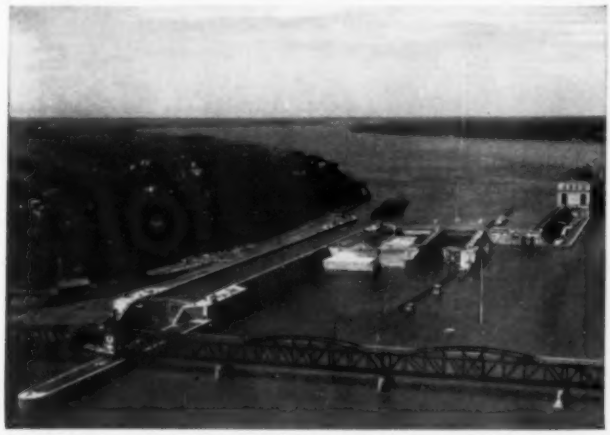
From Oilgear Application-Engineering* Files

HOW OILGEAR AE* HELPS THE ARMY ENGINEERS SPEED MISSISSIPPI RIVER TRAFFIC

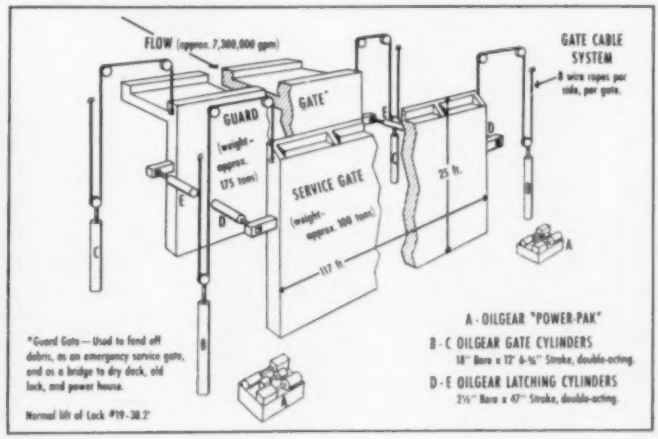
CUSTOMER: *Corps of Engineers, U. S. Army, North Central Division, Rock Island District*

DATA: Power and control system for lifting, lowering, and latching the 110-ft, single leaf, vertical lift, upper service and guard gates on new 1200-ft Mississippi River Lock #19 at Keokuk, Iowa.

REQUIREMENTS: 1. Foolproof, dependable, fast operation. 2. Simple, automatic, three-speed control from central station, interlocked electrically with lower miter gate, tainter valves, and lock water level. 3. System must incorporate: (a) Automatic latching, (b) Skew control to keep gates level during lifting and lowering, (c) Provision for emergency closing, (d) Automatic positioning for controlled supplemental fill of lock chamber over service gate top, (e) Additional lift-travel for cable and seal servicing, (f) "Fail-safe" operation in event of power failure.



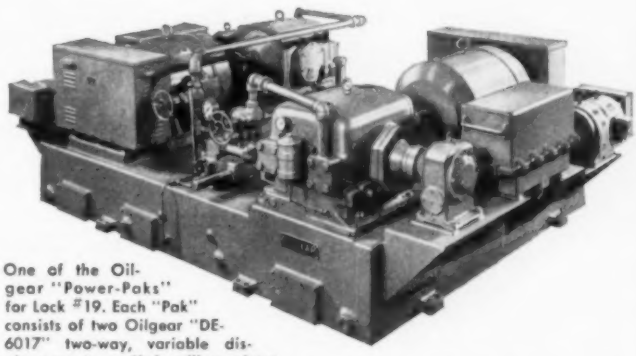
A typical "tow" entering new Lock #19 from upstream. In "locking-down" it will pass over the Oilgear-powered upper guard and service gates. Several "tows" can simultaneously "lock-thru" intact. New upper guard gate also serves as an access bridge to a dry dock and the old lock visible to the right of the new lock.


FLOW (approx. 7,300,000 gpm)
GATE CABLE SYSTEM
8 wire ropes per side, per gate.
GUARD
(weight - approx. 175 tons)
GATE*
SERVICE GATE
(weight - approx. 900 tons)
25 ft.
117 ft.
A
B
C
D
E
A - OILGEAR "POWER-PAK"
B - C OILGEAR GATE CYLINDERS
18" Bore x 12' 6-½" Stroke, double-acting.
D - E OILGEAR LATCHING CYLINDERS
2½" Bore x 47" Stroke, double-acting.
*Guard Gate — Used to fend off debris, as an emergency service gate, and as a bridge to dry dock, old lock, and power house.
Normal lift of Lock #19 - 38.2'

SOLUTION: An Oilgear *Application-Engineered* Fluid Power System which surpasses all originally specified requirements . . . as shown above in simple schematic form. This system consists of two Oilgear "Power-Paks" (A), four Oilgear custom, double-acting gate cylinders (B-C) — with integral solenoid pilot-operated brake valves, and four Oilgear custom, double-acting gate-latching cylinders (D-E). Entire upper gate control system is interlocked electrically with the lower miter gate and tainter valves for maximum operating safety. In event of power failure, solenoid pilot-operated brake valves, integral with cylinders, stop gate movement for "fail-safe" operation. Automatic skew control prevents "cocking" or binding of gates. A difference of 1½" in side height automatically reduces displacement of leading gate cylinder pump to allow lagging cylinder to catch up. Gate "down-cycle" power regeneration is an outstanding "Oilgear-plus" feature that furnishes exceptional electric power economy . . . utilizes the downward load on cylinder fluid to drive the Oilgear pumps as motors, reducing electrical power input. To speed lock filling, upper service gate automatically lowers to a supplementary fill position permitting controlled flow of water over gate top. Gate holds this position until water levels of upper pool and lock chamber are equalized, and automatically proceeds down at high speed. If water levels are equalized prior to start of cycle, gate does not stop at supplementary position. "Fill" time is only 10 minutes, drain time — 9¼ minutes. Entire "lock-thru" time for an 11-barge tow has been reduced from 7¼ hours to approximately 20 minutes with this new lock. In emergencies, upper gates can be raised or lowered against full river flow. Oilgear *Application-Engineered Controlled Motion Systems* are simplest to install, operate, and maintain . . . require less power to operate, reduce installed costs . . . are complete systems for specific applications — with one responsibility for the entire system.

* * *

Similar Oilgear systems are operating the St. Lawrence Seaway Eisenhower Locks, the Monongahela River Locks, the Bayou Boeuf Locks, the Dalles Locks, the McNary Lock — all projects of the Corps of Engineers . . . as well as operating miter gates, tainter valves, capstans . . . shipboard steering and flanking gear, winches, catapults, elevators, mobile oil drilling barges, and in all phases of industry.



One of the Oilgear "Power-Paks" for Lock #19. Each "Pak" consists of two Oilgear "DE-6017" two-way, variable displacement, radial rolling piston pumps coupled to 50-hp electric brake-motors; two electric pilot gearmotors, reducers, limit switch boxes, and right angle worm-gear drives to pump controls. Also included are a manually operated Oilgear change-over valve, an Oilgear "HG" constant displacement axial piston pump for operating the latching cylinders — all on a custom oil reservoir base . . . completely wired and piped, ready for installation. Each Oilgear variable displacement pump is piped to one of the large gate cylinders. In the event that pump maintenance or inspection is required, the manual change-over valve permits either pump on the "Pak" to be idle while the other pump operates either the service or guard gate.

for the lowest cost per year . . . it's Oilgear!

For practical solutions to YOUR rotary or linear drive and control problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

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FLUID POWER LINES

about hydraulics & pneumatics

SERVOS AGAIN . . . Back in May 1956, we devoted a whole issue to hydraulic and pneumatic servo systems. Because of the tremendous interest in this subject and the rapid-fire introduction of new products since then, this month's issue repeats this servo theme. You'll find the articles give basic information and application ideas that can be used on many different types of machines.

One of the most important trends in fluid power engineering is the use of electrohydraulic servo valves for jobs other than aircraft. Originally developed for aircraft surface control, (Bell Telephone's valve for the Nike dates back to 1945) servo valves are now common on numerically controlled machine tools, and have recently been successfully applied to a road grader.

Understanding the various designs, their characteristics, and performance is simpler if you study the special report, *What You Can Get In Servo Valves.* It's the most comprehensive article yet published to give information you need in selecting a valve.

OLD DEVIL DIRT . . . Along with the high accuracy of precision servo valves comes the problem of keeping them clean. Because of close clearances and small movements, dirt causes instability, slow response, and even complete failure. Two obvious solutions are cleaner fluid, less-susceptible valves. Not so obvious is how to do it. Some of the answers are in *How Contamination Affects Servo Valve Design.* These pointers will guide your valve selection.

POOR MAN'S SERVO . . . Not every servo system has to position a tool slide within a .0001 or keep a missile on course. Servos can be used for much less critical applications as shown by a counterbalance system designed by Gidding & Lewis and described on page 94. It uses a cam-actuated, 4-way valve modified for this job.

SMOKE A CIGARETTE . . . That's one job it can't do, but a new tape controlled machine introduced by Kearney & Trecker can select any one of 32 tools from a magazine, insert it into its spindle, select proper speed and feed and perform the operation. The designers have built up a lot of experience with servo controlled, fluid-motor/ball-screw drives. Advantages of this drive and considerations for selecting servo valves are explained in *Servo Controlled Fluid Motors Drive Multi-tool Machine.*

IDEA IMPORTS . . . From French aircraft design comes ideas on servo components described in this month's Aircraft Section. To eliminate leakage of a spool type valve, a rotary servo valve was designed. It has low friction and excellent flow characteristics. Other designs which are explained are a rotary torque motor, with a 40-degree rotation, and a rugged potentiometer.

FLUID POWER PATENTS . . . Starting in this issue, page 118, is a new editorial department covering recent patents in the hydraulic and pneumatic fields. Our study of patent abstracts showed they had many excellent ideas for component and system design. Each month we'll present several of the most useful in concise and easy-to-understand style.

drilling barges, and in all phases of industry.

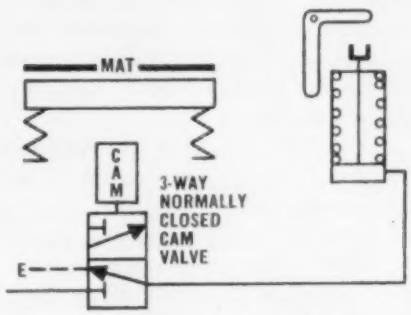
What? Air Won't Let Him Get Too Fat!

We admit we are not serious, but . . .

In a previous moment of strength he has set the controls—now, if he weighs over 200 pounds when he steps on the mat in front of the refrigerator, the door just won't open. But while he is under 200 pounds, no trouble. Now, it's highly unlikely that the refrigerator folks will be mobbed by eager buyers for such a diet-master model, but we have jumped on it as a good chance to show how a cam valve can say "yes" or "no."

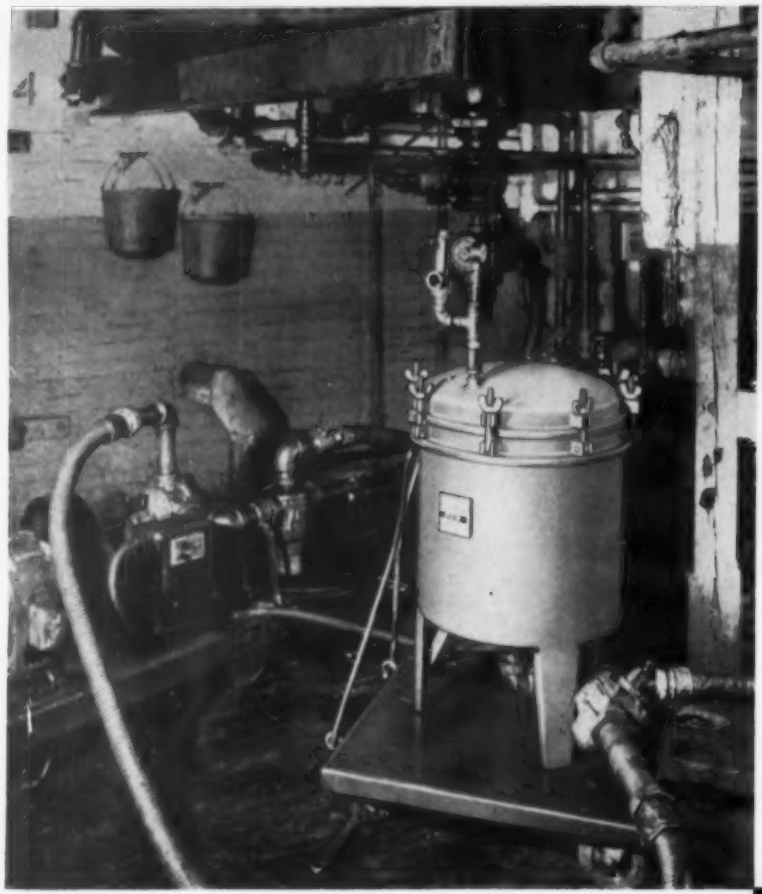
Ross Cam Valves can "think" for your circuits, too

Cam valves are the key to air automation. They can act on almost any mechanical signal to set off . . . or restrict . . . another operation. Then still another cam valve can interlock that circuit with yet further operations and so on until any number of operations can be sequencing one another. Are you realizing the full possibilities from cam valves? The Ross line includes so many models, we invite you to call your Ross representative or write us.



SEQUENCE OF OPERATION
Sufficient weight on mat depresses cam, operating valve and moving cylinder to point where it restrains door handle from opening.

Ross OPERATING VALVE CO. 105 E. Golden Gate Ave. • Detroit 3, Michigan



CFC FILTERS

Honan-Crane Filter clarifies esters and hydraulic fluids for E. F. HOUGHTON

CFC Honan-Crane Multi-Cartridge Filter employs Palconia (inert cellulose) to purify esters and hydraulic fluids prior to loading in 50-gallon drums. This portable unit is installed at E. F. Houghton & Co. in Philadelphia.

E. F. Houghton & Co., a leading producer of industrial lubricants, relies on the CFC Honan-Crane Multi-Cartridge Filter to remove micro-impurities from esters and hydraulic fluids. In this way they insure product quality that meets the rigid standards of the company.

The CFC Multi-Cartridge Filter is extremely versatile — employing seven types of interchangeable cartridges for selective filtration of practically all types of oils. Cartridges include inert materials and impregnated paper for suspended solids, or Cranite (fuller's earth) for removal of both solid and soluble impurities.

CFC Filters have quick-opening covers, and can be equipped with electric, steam or hot water heat. Auxiliary equipment such as pumps, motors and electric controls may be included with stationary or portable filters.

CFC Filters are engineered to your job requirements. For technical literature or engineering assistance, write to Dep't **AH**.

COMMERCIAL FILTERS CORPORATION
MELROSE 76, MASSACHUSETTS
PLANTS IN MELROSE, MASSACHUSETTS AND LEBANON, INDIANA

MICRO-CLARITY AT MINIMUM COST

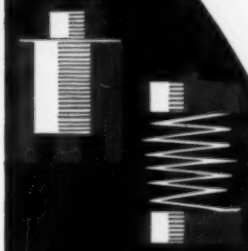
Fulflo FILTERS — *with genuine Honeycomb Filter Tubes for controlled micro-clarity of industrial fluids.*

CFC FILTERS — *Selective filtration of oils • water-oil separators • magnetic separators • pre-coat filters • coolant clarifiers • automatic tubular conveyors.*

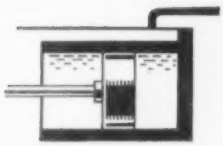
RACINE-SECO

now offers for your hydraulic circuits

MECHANICAL



ELECTRIC



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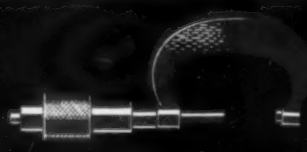
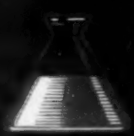
the controls of your choice . . .

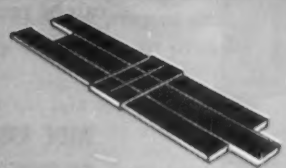
for the results you want



ACCURACY



RELIABILITY



FLEXIBILITY

SIMPLICITY

The method of pump control you choose determines the final results of your hydraulic circuit. RACINE - SECO makes available a complete range of controls for all requirements.

Let a RACINE - SECO representative help you select the right method of control for your operation. From a simple mechanical control to the most comprehensive electronic feed-back system, a RACINE - SECO engineered circuit will give you the results you want.

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FULFLO

piston-type oil relief by-pass valves for O.E.M. or replacement

Best Buy because

QUICK DELIVERY

Fulflo stocking policy *and* practice permits quick shipment from stock of most standard types. Shipment is usually made *within 24 hours.*

TECHNICAL SERVICE

Fulflo engineers are ready *and* able to help you with any valve problem. Modified standard or special valves can be provided for any need.

WIDE RANGE OF TYPES AND SIZES

- Standard and flanged models
- Just 6 springs for pressures to 500#
- Wide range of brass, cast iron or steel bodies . . . brass, steel or stainless pistons
- Pipe sizes to 3"
- SPECIALS to your requirements

Write for "Fulflo Valves Mechanical Data Book"

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LETTERS to the editor

Address your letters to: Editor, APPLIED HYDRAULICS & PNEUMATICS MAGAZINE, 812 Huron Rd., Cleveland 15, Ohio.

Training Material

TO THE EDITOR:

Will you please send me your book on Basic Pneumatics for examination and possible adoption for the course titled Hydraulics, Pneumatics and Electrical Control to be offered at the University of Toledo.

Your suggestions of material which will help us plan this course would be appreciated.

RICHARD J. WOJCIKOWSKI
Lecturer in Industrial Technology
University of Toledo

A copy of our Basic Pneumatics booklet has been sent. Price per copy is $1.50. In quantities of 100 or more for schools, the price is $1.00 per copy. We've sent a photocopy of a bibliography of books and films which was published in the 1958/59 Fluid Power Directory.

Servo Information

TO THE EDITOR:

With great interest we read your magazine. But very often it gives us some difficulties in understanding several problems about servos and their systems. We should like to know if you have any advice which would help us.

We already make use of your Fluid Power Directory.

S. DE VRIES
Mermes' Factory
of Agriculture Equipment
Leeuwarden, Holland

We have sent a bibliography. And this servo issue gives you the best up-to-date source of information.

NCIH Papers

TO THE EDITOR:

Would you please send us information on how to obtain the following technical papers summarized in the October Issue of

Continued on page 16

another

NEW BOOK

with that

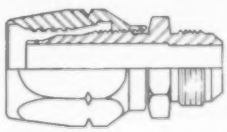
Eastman

LOOK

36 pages on medium to low pressure hydraulic hose and tube assemblies

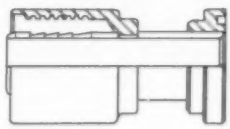
REUSABLE COUPLINGS FOR RUBBER COVER HOSE

Exclusive Eastman design directs flow of hose into machined recesses of insert and coupling body. Doubles the hold, assuring longer service. Pages 26 & 27.



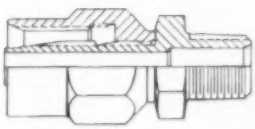
PERMANENTLY ATTACHED FLANGE HEAD COUPLINGS

Attractive, low cost permanent hose attachment—plus convenience of split-flange head couplings with 0 to 90° stems permitting full 360° positioning. Pages 20 & 21.



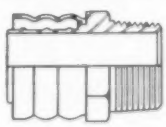
REUSABLE COUPLINGS FOR COTTON COVER HOSE

Eastman engineered two-piece coupling can be assembled without stripping hose. (Can also be used on thin rubber cover hose without removing cover.) Full details on pages 24 & 25.



PERMANENTLY ATTACHED COUPLINGS FOR SUCTION HOSE

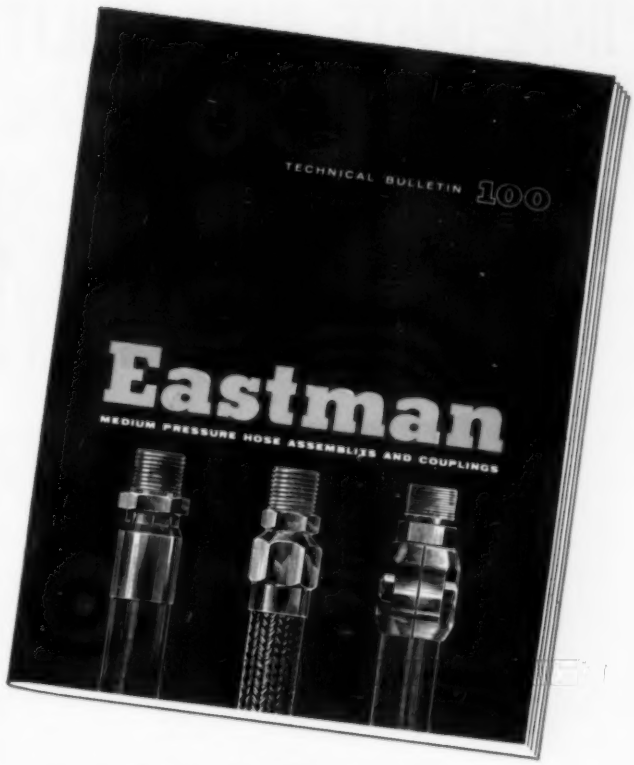
For use on spiral wire return lines. Maximum orifice permits rapid return of hydraulic fluid assuring adequate supply from lever to load for top payload power. See page 31.



Eastman

first in the field

SAFEGUARDING AMERICA'S LIFELINES OF MOBILE POWER



ARRANGED FOR YOUR CONVENIENCE TO MAKE IT EASIER FOR YOU TO:

Locate your required assemblies
Determine the proper couplings
Specify according to pressure

EASTMAN'S New Technical Bulletins on Hydraulic Hose and Tube Assemblies are the talk of the trade!

Here's the second in the series which you will want to send for right away—Technical Bulletin No. 100 on Medium to Low Pressure Assemblies. Working Pressures range from 3000 psi to 75 psi (for return suction lines).

Easy-to-use tables arranged opposite dimensional drawings for the entire Eastman line of Couplings: Permanently Attached, Clamp Type, Flange Type and Reusable—for One Wire Braid Rubber Cover, Cotton Cover and Suction Hose—plus necessary adapters and tube fittings.

This is a necessary companion to the first in Eastman's New Series of Bulletins—No. 200, on High Pressure Assemblies. Be sure that your personnel is supplied with copies of *each* of these modern bulletins.

Write today! Send the quick service coupon below.

EASTMAN MFG. CO., DEPT. AH-2, MANITOWOC, WISCONSIN

Please send me.....copies of Bulletin 100 on Medium to Low Pressure Eastman Assemblies for 1-wire braid hose.

Please send me.....copies of Bulletin 200 on High Pressure Eastman Assemblies for 2-wire braid hose.

Also.....copies of Bulletin 500 on Adapters and Adapter Unions.

Name _____ **Title** _____

Company _____

Address _____

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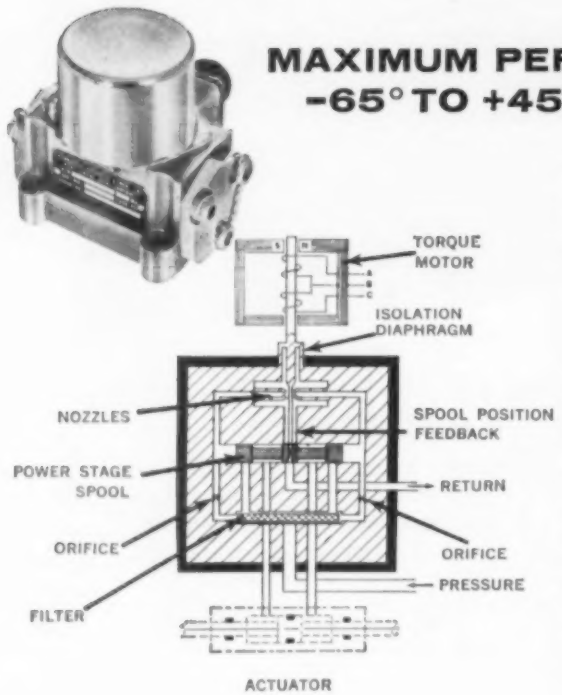
IMMEDIATE AVAILABILITY...*Hydraulic Research's new FLOW CONTROL TRANSDUCER*

ULTRA-HIGH STABILITY AT



MAXIMUM PERFORMANCE FROM -65° TO +450° F, AND TO 100 G's

Here is a completely integrated electro-hydraulic flow transducer developed exclusively for advanced, high performance control requirements. It is essentially unaffected by acceleration, vibration and temperature extremes.

TYPICAL PERFORMANCE DATA

Control Flow Range	0.15 to 15 GPM
Typical Electrical Input	80 milliwatts
Operating Pressure Range	150 to 4000 psi
Hysteresis	3% max.
Threshold	½% max.
Null Shift Due to Temperature Changes	5% max. —65 to +450°F.
Null Shift Due to Acceleration, Vibration, Shock	5% max. up to 100G
Operating Temperatures	—65 to +450°F.
Weight	1.0 lb. nominal
Flow Gain Linearity	±5%

Compatible with all hydraulic system fluids and most fuels.

no external null adjustment necessary

write for complete details

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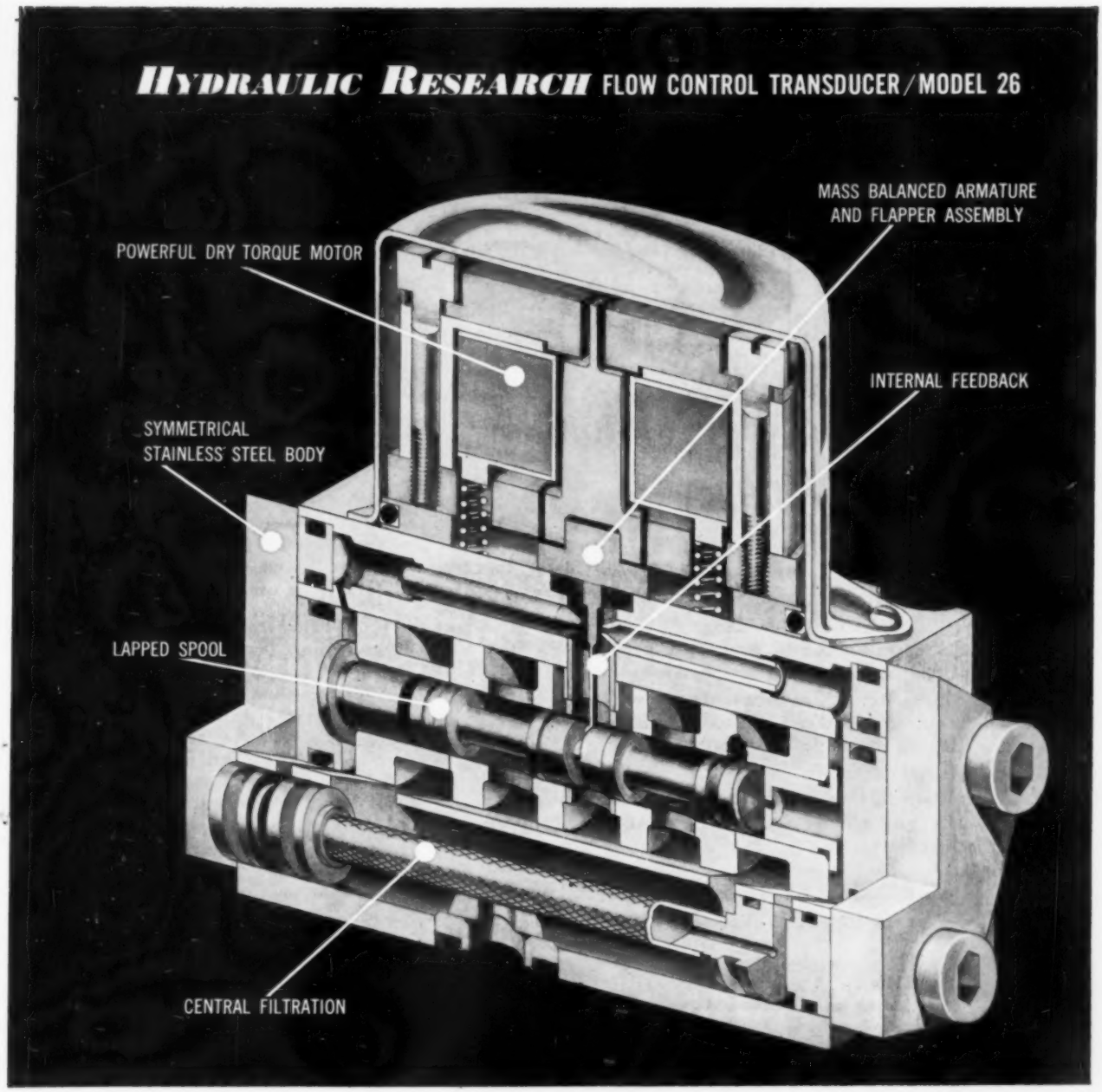
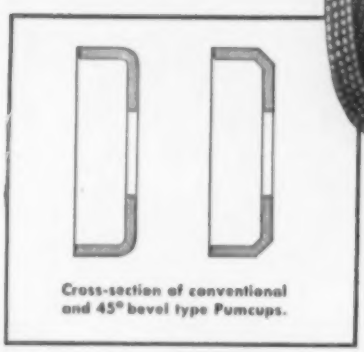
for 2nd generation missiles...featuring

EXTREME ENVIRONMENTS



Circle **59** on *Time-Saver Card*

2-way gain with Pumcups



Cross-section of conventional and 45° bevel type Pumcups.

Darcova Pumcups are available in various types and textures, in a complete range of sizes, to provide unequalled efficiency and long life in reciprocating pumps, air or hydraulic mechanisms.

★ prolonged high efficiency
★ less maintenance

TODAY hundreds of companies using hydraulic controls, air cylinders or reciprocating pumps are *standardizing* on Darcova Pumcups for piston packing, because they eliminate fluid slippage, costly down-time and maintenance.

Darcova Pumcups make the *most* of the cup packing principle. And, they are made in a complete range of sizes, types and texture-engineered compositions for various pressure-temperature-fluid conditions. Pumcups hold peak efficiency for the life of the cups and outlast other packing as much as 3 to 1.

Why not check these claims right in your own plant? Meanwhile get *all* the facts. Just send for Pumcup Bulletin No. 5503.

DARLING VALVE & MANUFACTURING CO.
Williamsport 15, Pa.

DARCOVA
TRADE MARK
PUMCUPS

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LETTERS

APPLIED HYDRAULICS & PNEUMATICS: Research on High Temperature Hydraulic & Pneumatic Systems for Aircraft, by Charles H. Cannon, and Investigation of the Performance of a Pressure Compensated Flow Control Valve, by Dennis W. Prosser.

J. F. BUTLER
Administration Engineer
B. H. Hadley, Inc.
Pomona, Calif.

You can quickly obtain the papers you want by writing directly to the authors. Charles Cannon is at Lockheed Aircraft in Marietta, Georgia, and Dennis Prosser can be reached by writing Illinois Institute of Technology, 3300 South Federal, Chicago, Ill.

Fluid Power Texts

TO THE EDITOR:

Please send us descriptive literature and prices of technical books you may publish on pneumatic and hydraulic equipment.

HAROLD J. HUDSON
Office Manager
Scott Equipment Co.
Wheeling, W. Va.

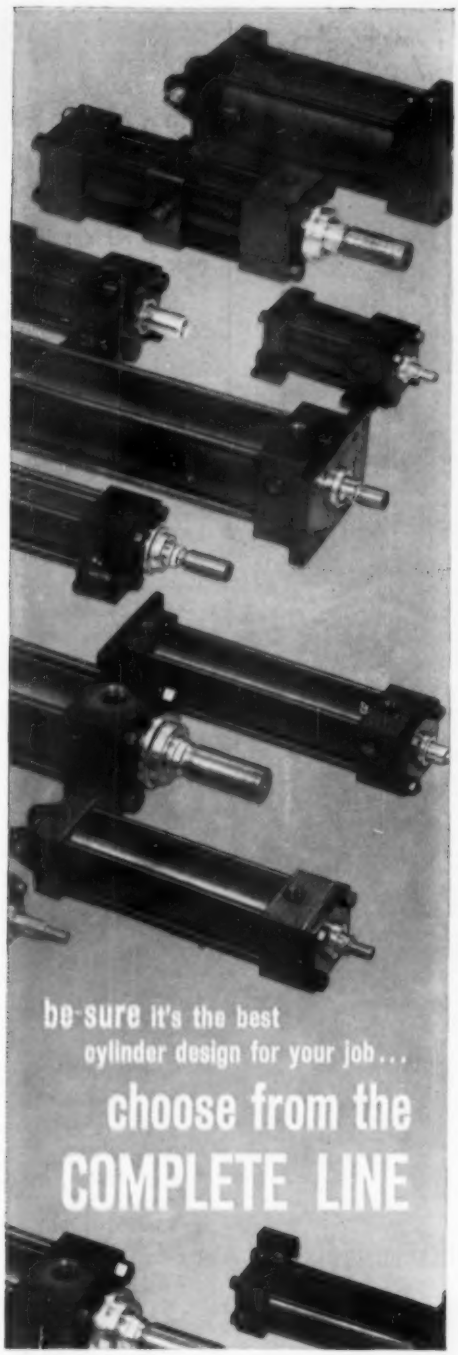
We have mailed you information about publications on fluid power published by APPLIED HYDRAULICS & PNEUMATICS Magazine.

Cleaning Stainless Steel Filters

TO THE EDITOR:

In the August 1958 issue of AH&P the section on SAE aircraft meetings contained an interesting note on the cleaning of reusable stainless steel filter elements. E. T. Raymond, research engineer of Boeing Airplane Company, seems to have experienced the same results as we in the cleaning of the elements. We find that reverse flushing, ultrasonic cleaning and acid baths do not effectively clean them. Presently, we are using 10 gpm line filters. Filter elements are stainless steel regimesh type. Micron rating is five nominal. Manufacturers of this type of filter describe them as reusable

Continued on page 18



Available for immediate shipment from stock for over 90% of all applications

Only Hydro-Line offers you the "Complete Line" of three series of industry standard, modern design cylinders enabling you to choose the type best suited to your job requirements. You needn't pay for "too much" cylinder for the job, nor do you have to "stretch" and risk tying up production by not buying "enough" cylinder.

Because all three series are standard, you keep initial cylinder costs low.

Because all three are standard series, you get fast delivery from factory stocks, permitting reduced inventories.

Here are the three standard Hydro-Line series that combine the newest ideas in cylinder design with proved performance in all classes of industrial service:

series R2 — 200 psi air, 500-2500 psi hydraulic, 1½" to 14" bores; meet J I C standards.

series N — 2000 psi and higher hydraulic service; 1½" to 12" bores; meet J I C standards.

series S2 — 200 psi air, 1000 psi hydraulic, ½" to 8" bores; meet J I C and automotive industry automation standards.

For more complete data on sizes carried in factory stocks — covering 90% of applications and including thousands of bore, stroke and cushion combinations, contact your nearby Hydro-Line representative or fill in coupon below and send direct to factory:

act now!

Please send me additional data on the classes of Hydro-Line cylinders checked below, including complete information on deliveries from factory stocks:

( ) Series R2 (heavy-duty air, medium-duty hydraulic, industry standard)
( ) Series N (heavy-duty hydraulic, industry standard)
( ) Series S2 (automotive industry automation standards)

Name and Title_____
Company_____
City_____ State_____

HYDRO-LINE MANUFACTURING COMPANY
5601 PIKE ROAD ROCKFORD, ILLINOIS

HYDRO-LINE CYLINDERS

5601 PIKE ROAD • ROCKFORD, ILLINOIS

manufacturers of: high- and low-pressure hydraulic cylinders • heavy-duty air cylinders • adjustable-stroke cylinders • dispensing cylinders • intensifiers • single-acting cylinders • booster cylinders

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Now-SAVE SPACE, WEIGHT & PIPING

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Modernair
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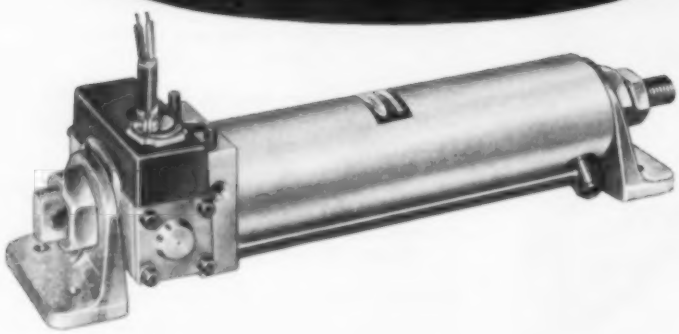
VIH (VALVE-IN-HEAD) CYLINDERS



Here's a combination that's hard to beat — a performance-proved industrial air cylinder with its own built-in directional and exhaust speed control valves — in a single, compact "package". Check these important features:

- **BUILT-IN DIRECTIONAL CONTROL VALVES...** your choice of four control combination; double solenoid, single solenoid with button bleeder return, double button bleeder, or double remote pilot pressure operation.
- **BUILT-IN EXHAUST SPEED CONTROLS** with automatic Nylon lock.
- **INTERCHANGEABLE MOUNTINGS...** front or rear flange, low or high "L" foot brackets, rod and cylinder clevis.
- **SINGLE CONDUIT CONNECTION** for double solenoid unit.
- **AVAILABLE WITH CUSHIONED STOP** either or both ends.
- **PERFORMANCE-PROVED MODERNAIR CONSTRUCTION**

Condensed Specifications

DIAMETERS: 1½", 2", 3"
ROD SIZES: ½", ⅝", ¾"
MIN. OPERATING PRESSURE: 20 p.s.i.
SOLENOID POWER REQUIRED: 10 watts
MAX. OPERATING PRESSURE: 150 p.s.i. (solenoid) 200 p.s.i. (bleeder or pilot pressure)
SOLENOID COILS AVAILABLE: (ac) 8-10, 110, 220 v. (dc) 12, 24, 30 v.

Call your local MODERNAIR sales outlet (see Modernair trademark under "CYLINDERS" in the yellow section of your phone book) or write us today for complete data bulletin; please address Dept. B-2.

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MEMBER NATIONAL FLUID POWER ASSOCIATION

Circle **75** on *Time-Saver Card*

LETTERS

after cleaning, but do not tell how to clean.

Can we get information on a practical and effective method for cleaning?

RICHARD F. HARTNETT
Methods Engineer
Raytheon Manufacturing Co.
Missile Systems Division
Waltham, Mass.

At this time, the only information we have sent Mr. Hartnett is the names of filter manufacturers who should be able to help. We have also asked SAE A-6 committee chairman Bob Teree if any report is being developed on filter cleaning methods. We will welcome further suggestions from our readers.

Who Makes Rotary Actuators?

TO THE EDITOR:

We would appreciate knowing the manufacturer of the high pressure rotary actuator as shown on page D/64 of the 1958/59 Fluid Power Directory. We have an application for an actuator of this type to be used in airborne equipment.

E. J. HASNEY
Radar Engineering
The Magnavox Co.
Fort Wayne, Ind.

Kelsey-Hayes is the manufacturer of the high pressure actuator. We don't know how far they've carried this development and whether it is presently available commercially. At the time we prepared the DIRECTORY *they supplied literature.*

Editorial Index

TO THE EDITOR:

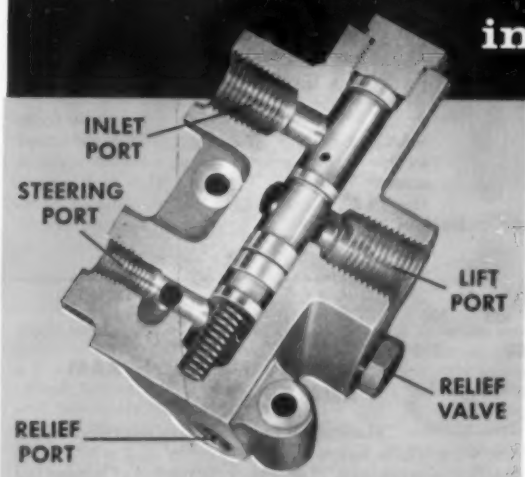
Is there available a compilation of articles published in APPLIED HYDRAULICS & PNEUMATICS?

J. RICHARDS
Airborne Accessories Corp.
Hillside, N. J.

Since 1952, the annual editorial index has been published in the December issues. Reprints of the 1958 editorial index are available. This index will be sent without charge to readers requesting a copy. □□□

DYNAMIC DIFFERENCE

in hydraulic performance



BULLETIN HY1A contains performance and installation data on the complete line of Webster positive displacement gear type pumps, fluid motors and valves. Write for your copy.

Call the man from Webster

. . . he's one of a staff of engineers, specially trained in hydraulic application. He can help you solve special problems when hydraulics become a part of your design!

photo courtesy of THE FRANK G. HOUGH CO., Libertyville, Illinois

Webster

HIGH CAPACITY FLOW DIVIDERS

Material moving magic! 20 cubic feet at a bite, this highly maneuverable front-end loader cuts big piles down to size—without missing a beat. Hydraulics play an important role here—in power steering, in powering the bucket. But there's only *one* hydraulic pump. A Webster flow divider supplies *both* hydraulic circuits—and permits each to be operated *simultaneously* at different pressures from a *single pump!*

There are more advantages . . . Webster flow dividers operate at pressures up to 2000 psi, capacities to 60 gpm. They're small, compact to fit easily in tight quarters on mobile equipment. Adapt easily and economically to your product and the job.

When *you* plan hydraulics, plan on Webster . . . *for the dynamic difference that pays!*

OIL HYDRAULICS DIVISION

WEBSTER ELECTRIC

RACINE · WIS

our 50th year

Circle **116** on Time-Saver Card

ACCO
Helicoid Gage
U.S.A.

NOTHING BUT THE BEST IN GAGES FOR WORKING PRESSURES FROM 30" VACUUM TO 10,000 p. s. i.

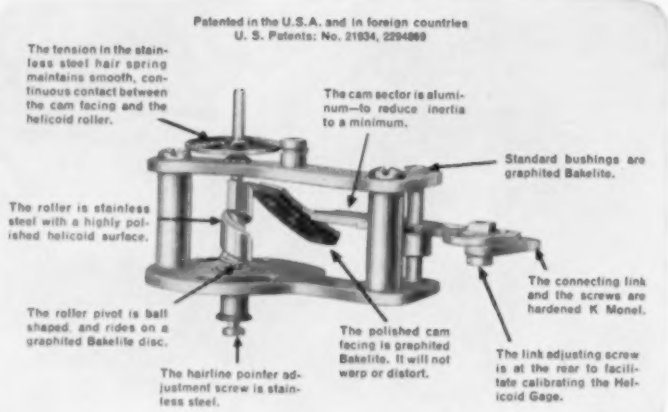
Shock-Proof Cam Actuation (no gears—no teeth) Makes Helicoid Gages Ideal for Hydraulic Services

Designed for pulsating and impact hydraulic service, the Helicoid movement releases at zero in the event of sudden pressure reduction. This eliminates shock on pointer and movement by reducing impact of pointer against pointer stop pin. This protects the gage mechanism where gages may be subject to occasional vacuum.

The superiority of Helicoid Gages is most evident in severe service—wherever a gage is subjected to violent pressure pulsations or certain severe mechanical vibrations.

The *sustained accuracy* of Helicoid Gages over *millions of cycles* is explained by the details of design and construction of the Helicoid movement shown at the right.

Rolling action of the cam facing against the roller surface . . . graphited Bakelite bushings, roller pivot base and cam facing . . . K Monel connecting links and screws . . . all such Helicoid features protect against wear and corrosion and assure sensitivity, sustained accuracy and trouble-free operation through millions of cycles.


Patented in the U.S.A. and in foreign countries
U. S. Patents: No. 21934, 2294869
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is aluminum—to reduce inertia to a minimum.
Standard bushings are graphited Bakelite.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

HELICOID GAGE CARTRIDGE SNUBBER

(Patent pending)

This is a simple, effective throttling device to reduce or eliminate pulsations of the gage pointer. There are no moving parts, no adjustments needed. Available in three types in powdered bronze or stainless steel for air, gas, water, steam, medium or heavy liquids.

Enlarged cutaway view

Threaded cartridge body for assembly in any Helicoid Gage tapped socket shank

EASIEST ADJUSTMENT AND CALIBRATION

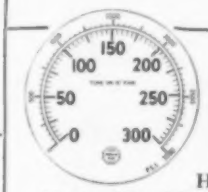
Only Helicoid Gages have the external pointer adjustment pictured here. The Helicoid type adjustment cannot be jarred out of position.

Calibration of Helicoid Gages is accomplished easily, without removing dial or pointer, because the link adjusting screw is at the rear of the system.

TUBES BUILT FOR MILLIONS OF PRESSURE PULSATIONS

To fit the wide range of applications, Helicoid Bourdon tubes are available in four materials—alloy steel, K Monel, stainless steel and phosphor bronze.

All Helicoid tubes are made from seamless tubing and are carefully designed to give maximum torque and minimum stress. When used within the dial range, they will withstand many millions of pressure pulsations and will not stretch, leak nor crack.



DOUBLE SCALE DIAL SHOWS TONS ON RAM AND PSI

Helicoid Gage dials are supplied in jet black with white figure markings or in dull white with black figure markings. They are constructed of laminated phenol with a transparent plastic surface and the longest possible scale length for more accurate readings. They are non-corroding, will not discolor nor fade and will not crack, chip nor peel.

Helicoid Gage Division
AMERICAN CHAIN & CABLE

929-H Connecticut Avenue • Bridgeport 2, Connecticut

ACCO
A·C·C
TRADE MARK

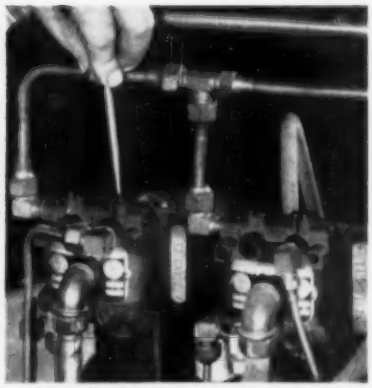
Helicoid gives you all these features at prices that are competitive in the quality gage field

Circle **53** *on Time-Saver Card*

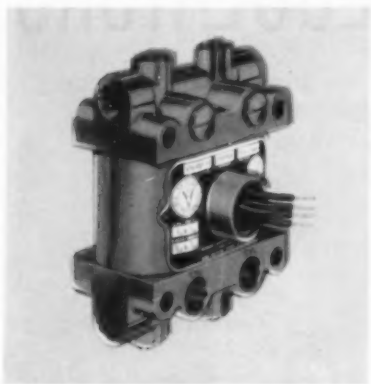
Why Skinner 4-way solenoid valves are used so widely for cylinder control

Application: A longitudinal and a transverse slide in this Pratt and Whitney Electrolimit Jig Borer is positioned automatically from numerical data on punched tape or manually by decade dials. When each slide has been correctly positioned it is held firmly by air-actuated, non-influencing clamps. Each clamp is controlled by a cylinder and a Skinner four-way V9 valve.

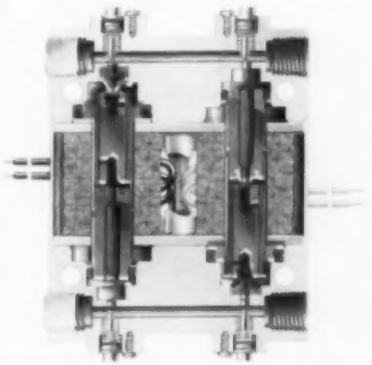
Features of standard valve did job. No special engineering of the four-way V9 valve was required to meet Pratt and Whitney's need. Molded oil-proof coils are used to guard against burnout from cutting solutions. The Skinner valve makes an ideal cross connection between electrical sensing and the muscular air required to provide the clamping action.



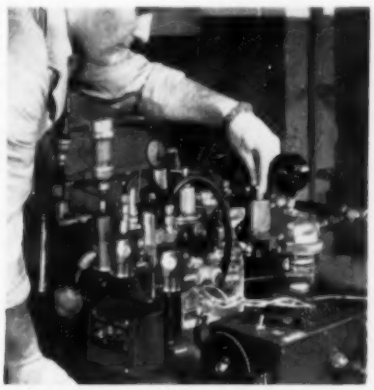
Dependable cylinder control. The four-way V9 valve is available with adjustable flow features in the main stream and in the exhaust passage for exceptionally accurate cylinder control. Position of inlet and exhaust connections can be changed easily in the field by simply reversing plugs.



Skinner V9 four-way valves, actually two 3-way valves in one housing are offered normally closed-normally closed, normally open-normally open, and normally closed and normally open. Media: air, inert gases, hydraulic fluids and vacuum; orifices: 3/64" to 1/8"; NPT ports: 1/4"; pressure ratings: to 250 psi. Over 350 basic variations.



Quality workmanship throughout. Internal parts are stainless steel and highly corrosion-resistant. Durable, compressible inserts of soft, synthetic materials insure bubbletight operation. Orifice seats have radius with well-rounded contact area and high finish for long insert life. Valve can be mounted in any position.



Exceptional life expectancy. Skinner valves, engineered to the highest UL standards, are life-cycled in the lab at speeds as high as 600 cycles per minute. In these tests, the V9 valves regularly get over 20-million cycles without leakage. And these results are constantly proving out in service.

Skinner solenoid valves are distributed nationally.

For complete information, contact a Skinner Representative listed in the Yellow Pages or write us at Dept. 312

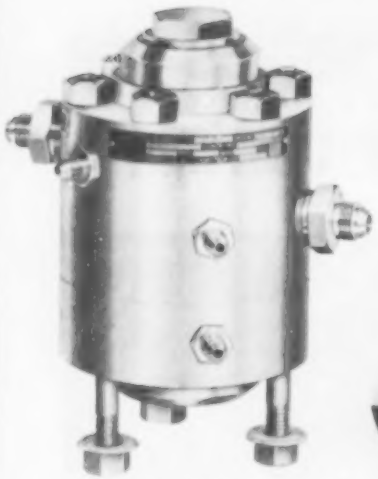
SKINNER ELECTRIC VALVES

THE CREST OF QUALITY

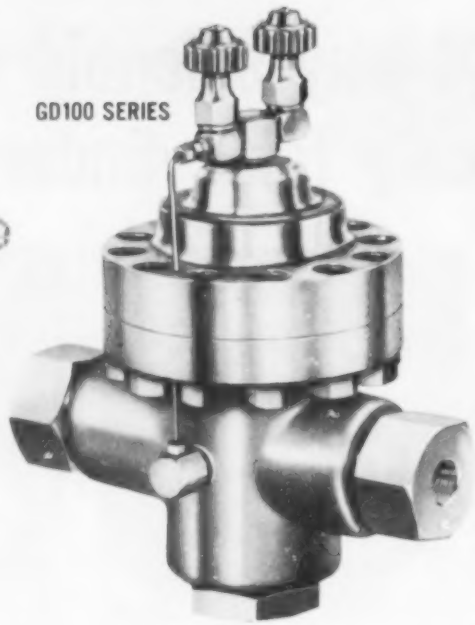
SKINNER ELECTRIC VALVE DIVISION

NEW BRITAIN CONNECTICUT

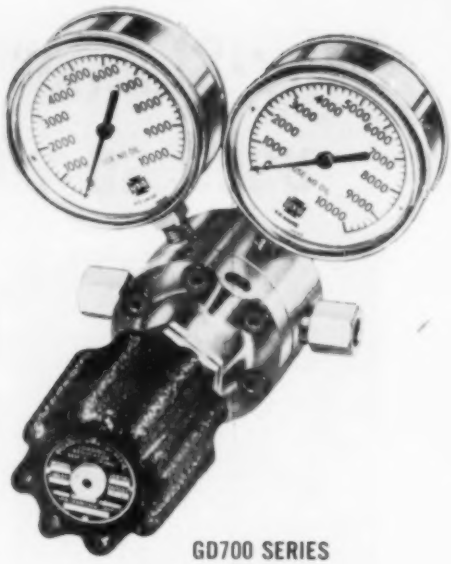
105 EDGEWOOD AVENUE



GD60 AND 80 SERIES



GD100 SERIES



GD700 SERIES

Control gases safely, accurately

to 15,000 psi and 200,000 scfh with VICTOR REGULATORS

You get precise regulation of high pressure gases with large flow rates, because Victor employs gas pressure to control the regulating diaphragm. The result is accurate delivery from 5 to 15,000 psi with inlet pressures to 15,000 psi . . . plus ability to obtain flows in excess of 200,000 scfh at maximum inlet and outlet pressures. Chart below shows operating range of standard models.

MODEL NO.	MAX. INLET PSI	MAX. OUTLET PSI	FEATURES	MAX. FLOW SCFH
GD10	3,600	500	Single adjustment regulator control	15,000
GD30	2,500	2,500	Load & bleed valve control	25,000
GD31	3,600	3,600	Load & bleed valve control	36,000
GD61C	2,500	2,500	Load & bleed valve control	10,000
GD62C	3,600	3,600	Load & bleed valve control	12,000
GD65	6,000	6,000	Load & bleed valve control	15,000
GD65C	7,000	7,000	Load & bleed valve control	15,000
GD80A	5,000	5,000	Load & bleed valve control	30,000
GD81A	10,000	10,000	Load & bleed valve control	50,000
GD86R	10,000	10,000	For remote control only	75,000
GD100R	6,000	6,000	For remote control only	240,000
GD100	6,000	6,000	Load & bleed valve control	240,000
GD700	7,000	7,000	Single adjustment regulator control; self relieving	15,000
SR10	3,600	1,000	Small, spring loaded regulator	200
LR20B	7,000	7,000	Spring loaded regulator; self relieving	120

Operating temperature range: −67° F. to +250° F.

. . . Yours for the asking
Take advantage of Victor's long experience with high pressure gas regulation to help solve your special problems involving flow rates, delivery pressures, corrosive fluids and temperature compensation. Write, wire or phone us today. No obligation.

All models listed are field proved. Most are designed for panel mounting or remote control. They regulate all non-corrosive gases, including oxygen. Stainless steel models available for corrosive gases and pressures above 10,000 psi. For complete specifications, write for Victor High Pressure Regulator sheets.

VICTOR for regulators

VICTOR EQUIPMENT COMPANY

Mfrs. of High Pressure and Large Volume Gas Regulators; welding & cutting equipment; hardfacing rods; blasting nozzles; cobalt & tungsten castings; straight-line and shape cutting machines.

844 Folsom St., San Francisco 7 • 3821 Santa Fe Avenue, Los Angeles 58 • 1145 E. 76th St., Chicago 19

J. C. Menzies & Co., Wholly-Owned Subsidiary

Now! With All-New High Efficiency Regulator!

ALEMITE

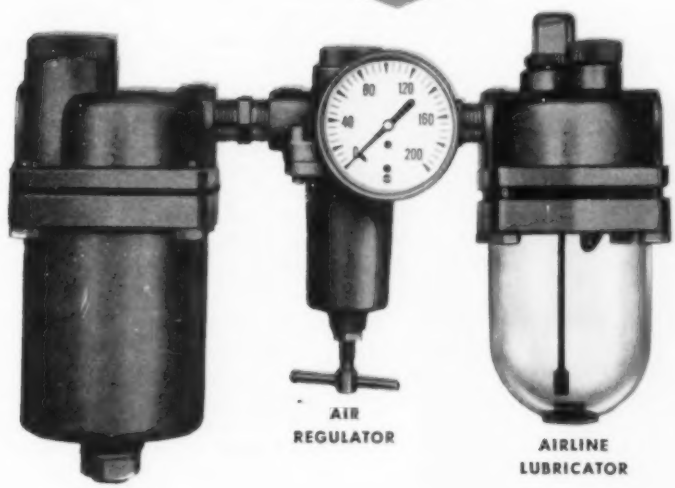
"Tri-Duty" Airline Controls

...FOR THE CLEANEST, DRIEST, BEST-REGULATED AIRLINE LUBRICATION...

Automatic Water Separator! Removes all of condensate, all the time. Traps dirt particles to prevent damage to sensitive airline devices. Handles all airline pressure up to 200 PSI and flow volume from 5 to 50 CFM.

New Air Regulator with Gauge! Assures accurately controlled air—prevents erratic operation and damage to equipment. Design permits inlet pressures of 250 PSI—adjustments up to 125 PSI. Excess air pressure "bleeds off," within regulator, instantly.

Automatic Airline Lubricator. Compensating ball valve design controls air flow. Oil particles are atomized for most efficient transmission through supply lines. Result—uniform mixture regardless of air pressure and volume. Oil and air mixture proportionately constant. Reservoir may be filled at any time, assuring continuous operation. Nine-ounce capacity.



WATER SEPARATOR

AIR REGULATOR

AIRLINE LUBRICATOR

ALL-NEW FEATURES OFFER OUTSTANDING ADVANTAGES:

- Ideal for air tools, air cylinders, air motors, etc.!
- Most efficient airline lubrication available!
- Specifically designed for extensive service life and peak efficiency under adverse operating conditions!
- Engineered to give greatest three-way protection, durability and efficiency . . . in a complete package!

Mail Coupon for Full Information!

Symbol of SW Excellence

ALEMITE DIVISION
STEWART-WARNER CORPORATION

1850 Diversey Parkway, Chicago 14, Illinois

ALEMITE, Dept. EE-29
1850 Diversey Parkway, Chicago 14, Illinois
Please send me all the facts about Alemite's new "Tri-Duty" Airline Controls.

Name_____

Company_____

Address_____

City_____ Zone_____ State_____

Circle **6** on Time-Saver Card

Circle **112**

BRIEFS

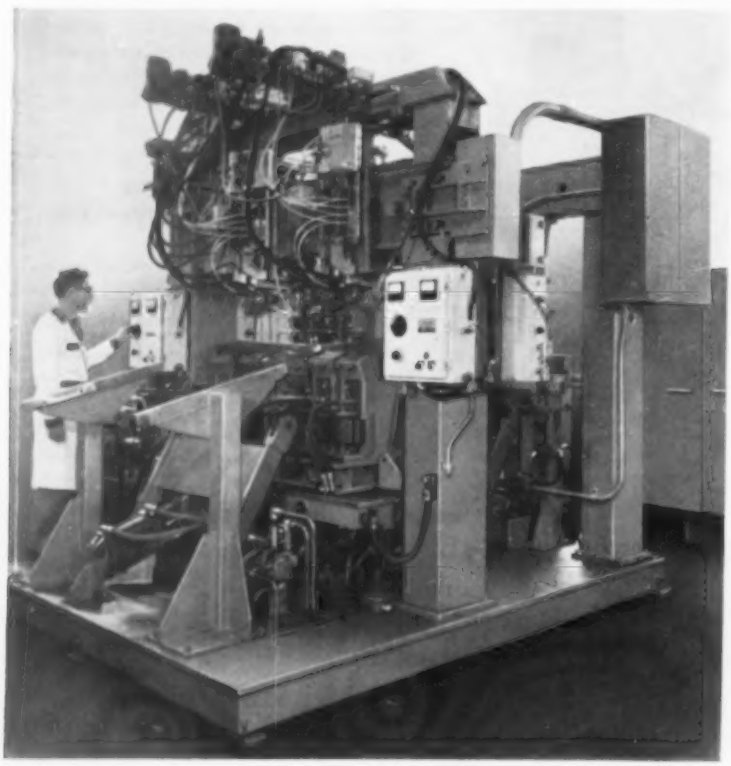
about fluid power

HYDRAULIC SERVO FOR AUTOMATIC WELDER

Machine uses a magnetic tape tracer system that welds metal parts having untrimmed, out-of-tolerance or contour weld edges in a continuous operation. It has self-powered welding heads which automatically follow any type welding contour.

A mechanical probe mounted through a slide on the welding head carriage follows the weld contour line. Movements of the slides are transmitted into a differential whose output then represents the error between the actual and the design weld line. This displacement error is then recorded on a loop of magnetic tape where is is temporarily stored. A reading head, located on the same tape loop a few inches behind the recording head, picks up this error and feeds it through a simple amplifier and hydraulic valve to a hydraulic servo cylinder. The servo cylinder corrects head position with respect to the welding carriage to correct for the reported error.

Probe is positioned a few inches ahead of the welding head to prevent weld splatter deposits. Distance between welding head and probe is equal in time units to the distance between the recording and reading heads.



Built by Expert Die and Tool Co., Inc., Detroit, Mich., the machine uses a loop of magnetic tape to eliminate rewinding. An erasing head behind the reading head removes the signal from the tape after it has been used. Tape can be used many thousand times before replacing. □□□

Scotch And Coke Gives Gland Trouble

Sounds like a mixture that would give more than one type of gland trouble but we'll stick to the mechanical packing gland.

A large scotch whisky distillery in Leith, Scotland, uses a reciprocating pump to transfer 15,000 gph of 80-proof whisky to various parts of the plant. Sealing the glands was a problem and over 50 gallons per week were being lost through leakage. (Wouldn't that break your heart?) Because the glands were padlocked by customs officials, re-packing was a long process.

James Walker & Co., Ltd., England designed a special chevron packing for the gland that has completely stopped the leakage.

In a similar application, the United Kingdom branch of the Coca-Cola Export Corp. had difficulty finding O-rings for static seals on storage tanks. The beverage is stored in stainless steel tanks and over a period tends to pick up an unpleasant taste from natural and synthetic rubber seals. Testing proved that silicone grade 60/2 rubber resisted the concentrate and gave no taste to the drink. □□□

Continued on page 26

HUNT

sets the pace again...

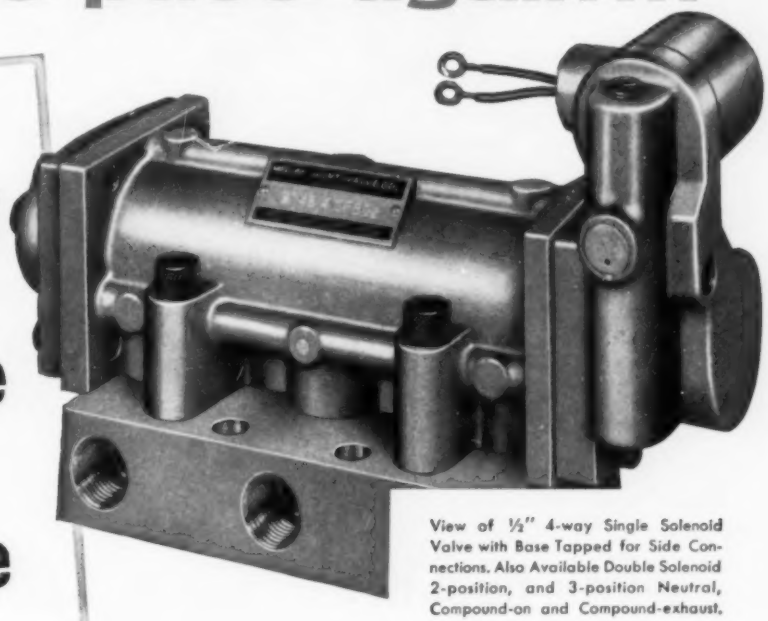
with a

FULL FLOW

½" Valve

at a

½" Price



View of ½" 4-way Single Solenoid Valve with Base Tapped for Side Connections. Also Available Double Solenoid 2-position, and 3-position Neutral, Compound-on and Compound-exhaust.

. . . in a completely comprehensive range of valve actions

THE UNIVERSAL SIZE. We asked O.E.M. buyers, large and small users; men out in the plant and plant managers,—"If you had to standardize on just one size of control valve, what size would you select?" Almost without exception they replied;—"½" size, it meets 85% or more of our requirements".

UNTIL NOW buyers have had to choose between a ⅜" valve tapped ½" but with **only ⅜" flow** (about 167 CFM); or, a ¾" valve tapped ½" but **selling at the ¾" price.**

AGAIN HUNT LEADS. Now, from Hunt, you can get a **full flow ½" valve** (257 CFM at 100 psig) in a complete range of actions, 2-way, 3-way, 4-way and 5-way, including single and double solenoid in AC or DC, any voltage, any cycle, explosion proof solenoid if desired; also hand lever, double pilot, pilot operated automatic return, and mechanically operated both directions, or with automatic return.

GET FULL DETAILS NOW about these new Hunt Valves that give you the flow you need, in the action you want, **at a ½" rather than ¾" price.**

More startling HUNT designs to come!

Send for Bulletin No. 582-A TODAY!

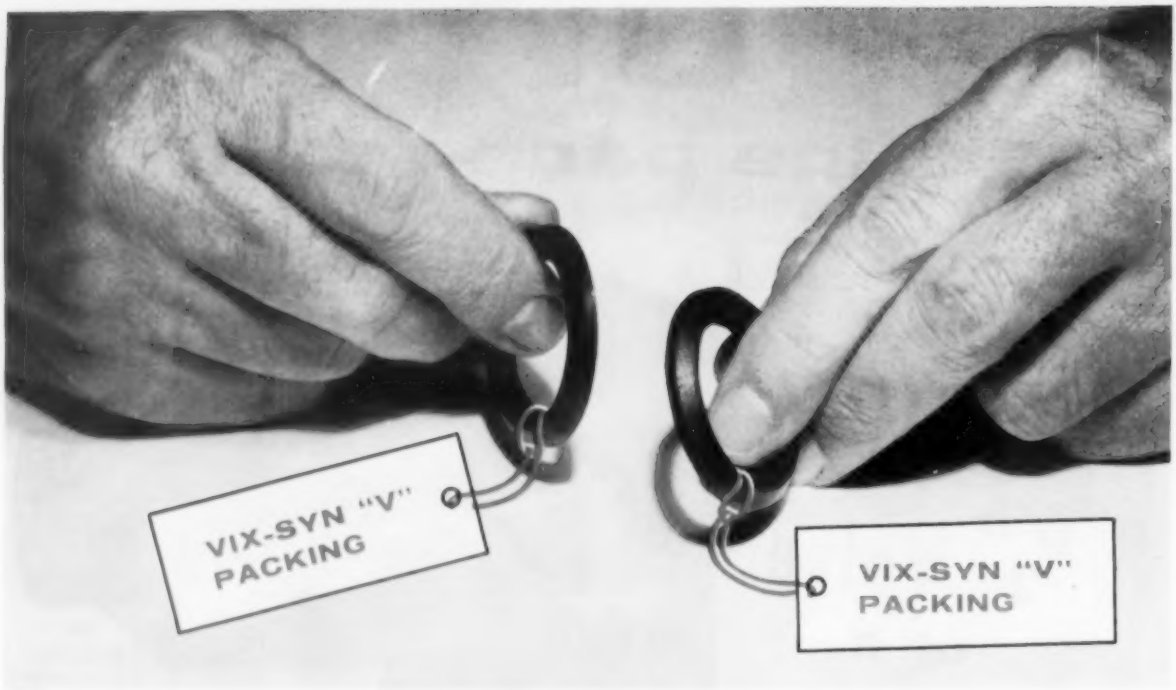
1919 1959 40 YEARS

HUNT

Quick-As-Wink® AIR AND HYDRAULIC CONTROL **Valves**

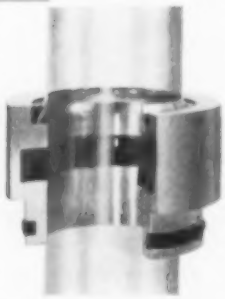
Manufactured by HUNT VALVE COMPANY, 1993 East Pershing St., Salem Ohio

Circle **56** *on Time-Saver Card*



Which HOUGHTON "V" ran 6,000,000 strokes?

Exclusive Houghto-Seal Guard



Takes dirt off piston rods
Keeps hydraulic systems clean!

Flexible, knife-sharp, bronze scraper rings, mounted in resilient rubber, remove all dirt and grit from piston rods. Will not score rods yet keeps dirt and grit out of system—easily applied in any rod diameter from ¼ to 6". Ask the Houghton Man for full details.

One of these fabricated rubber "V" packings is brand new. The other ran 6,000,000 strokes in a 1-ton press under test in a user's plant. (It's part of a set of four Houghton VIX-SYN "V's" used to seal the ram on a new line of one and two-ton presses.)

Because of the time involved, the test was stopped at 6,000,000 strokes. But, as you can see, even after this grueling test, the packing showed no wear. In fact, even a close inspection won't tell you which "V" was used in the test. (We had to mark the tag to keep from getting it mixed.) It's the one on the right!

Wear resistance like this is typical of Houghton fabricated VIX-SYN packings. For full information on them write E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa., for folder, "Houghton Fabricated VIX-SYN "V" Packings."

VIX-SYN Fabricated and Homogeneous Rubber and VIM Leather Packings

. . . products of

E. F. HOUGHTON & CO.
PHILADELPHIA • CHICAGO • DETROIT • SAN FRANCISCO • TORONTO

Ready to give you on-the-job service

Circle **55** *on Time-Saver Card*

BRIEFS

Hose Association Elects First President

The National Hose Assemblies and Fittings Manufacturers Association unanimously elected William F. Rogge, general manager of Aeroquip Industrial Division as its first president. The association was formed less than a year ago to coordinate engineering

William F. Rogge

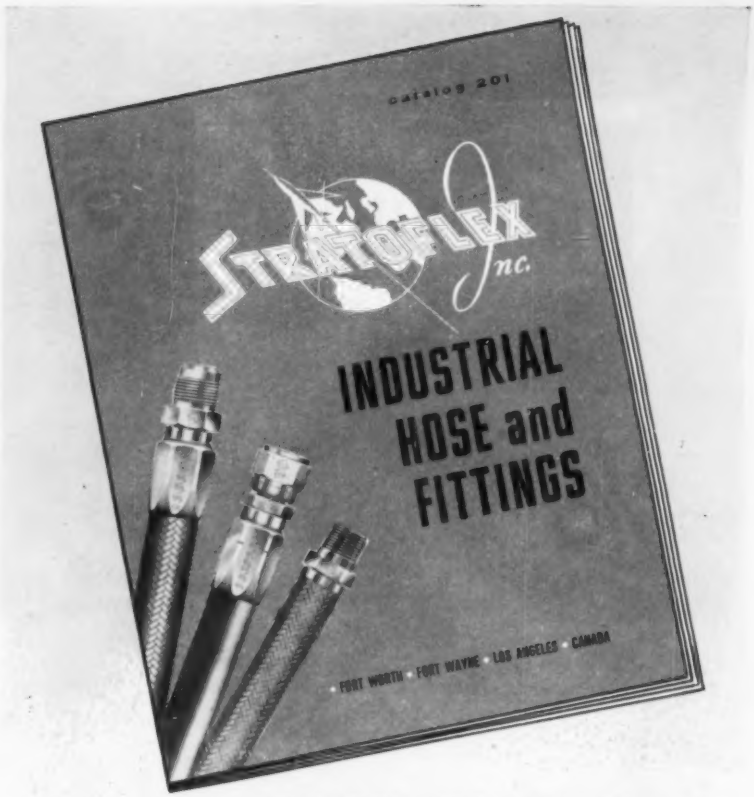
standards and compile statistical data for the hose assemblies and fittings industry. Elected with Rogge were vice president Walter Fritsch, Anchor Coupling Co. and an 11-man executive committee, consisting of Rogge, Fritsch, Norman Couty, American Coupling Corp.; Walter Schuknecht, Eastman Mfg. Co.; T. K. Wells, Flexonics Corp.; G. J. Duerr, Imperial Brass Mfg. Co.; John J. Kellas, Parker-Hannifin Corp.; Alfred C. Thurnlow, Reda-Turner Mfg. Co. Inc.; Stanley J. Zielinski, Surge-Pruf Sales Div., Stewart Warner Corp.; C. A. Thomas, Stratoflex, Inc.; and A. S. Wade, Weatherhead Company.

The Association's offices are at 53 Park Place, New York City. □□□

Hydraulic Motor Powers Gang Punch

Round heating ducts are made by piercing square sheets of 14 to 26-gage metal at each end, rolling it into a circle, and rivetting. Originally the hole locations were

Continued on page 28



Get this NEW Stratoflex Industrial Catalog NOW!

- Contains complete information for specifying single and double wire and fabric braid hose along with Stratoflex industrial fittings.
- Includes a section on special application hose and shows Stratoflex equipment for field assembly of hose and fittings for fluid lines.
- Comprehensive Hose Selector Charts are included, along with easy-to-read diagrams illustrating the proper installation of flexible hose.
- All-new technical data section contains helpful Industrial Weight Charts and a Thread and Decimal Equivalent Chart.

Mail Coupon Below for Your Free Copy Today!

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SFZ-9

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Please send me your new 64-page Industrial Catalog:
Name _____ Title _____
Firm _____
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Circle **103** on Time-Saver Card

Pathon Series WAL...WHL

AIR AND LOW PRESSURE HYDRAULIC

Cylinders

You can improve the durability and appearance of your equipment with the new Pathon W Series Air and Low Pressure Hydraulic Cylinders.

Valuable space can be saved with these proven screw thread head units. They are available in all standard mounting types plus the type 8, intermediate flange mount (illustrated above) in bore sizes from 1⅛" thru 6".

Specify WAL for air or WHL for oil service to 200 psi. These economical units incorporate non ferrous barrels, hard chrome plated rods, and "U" cup rod packing for minimum friction.

Specify WAT for air service to 250 psi; or WHT for oil service from 350 to 500 psi, depending on bore size. These units incorporate hard chrome plated steel barrels, case hardened, chrome plated rods, and multi-lip rod packing.

All Pathon cylinders have externally replaceable rod packing.

Write for Bulletin #25

Pathon MANUFACTURING COMPANY

3823 PACIFIC AVE. • CINCINNATI 12, OHIO

A-59

FLUID OPERATED AND CONTROL EQUIPMENT

Circle **85** *on Time-Saver Card*

BRIEFS

marked, pricked-punched, and pierced individually.

General Electric at Pittsfield, Mass. designed a gang punch to eliminate the hand work.

The machine uses a hydraulic motor to drive a series of cams

which actuate punches. A hydraulic power pack delivers 3 gpm at 1000 psi to the hydraulic motor driving the camshaft. Under these conditions, the shaft transmits 10,000 lb-inches of torque to the cams. Piercing is done in sequence, so that full motor output is concentrated on piercing each hole. A 4-way, foot-operated valve starts and stops the motor. □□□

Continued on page 30

AUTOMATIC LOADER for gear shaver handles four different setups on a single part. An air cylinder powers a rocker arm that removes gears one at a time from an input magazine. It deposits them in a location where air-powered head and tailstock position them for shaving operation. While this is happening a finished gear is being removed and placed on an exit chute. National Broach & Mach. Co., Detroit, Mich.

NOW with DC SOLENOIDS

6, 12, 24 or 36 volts

Only $10 extra per solenoid • Immediate delivery

A COMPLETE LINE OF TOP QUALITY VALVES

° Available for pressures up to 3000 PSI ° Choice of 4 spool actions: spring centering, spring offset, no spring in detent or friction pad type ° Choice of 3 standard spools and 5 alternates ° Tandem spools available at no extra cost ° ½" and ¾" pipe sizes. ° Full area internal porting

*Check these prices**

Lever Operated—No Spring ..... **$52.00** retail
Stem Operated—No Spring ..... **$50.00** retail
Cam Operated—Spring Offset..... **$62.00** retail
Air Pilot Operated—No Spring ... **$73.00** retail
Oil Pilot Operated—No Spring.... **$42.00** retail
Pilot Operated, Solenoid Controlled —No Spring .... **$90.00** retail
Add $10.00 for each D.C. Solenoid

*Prices applicable in the U.S.

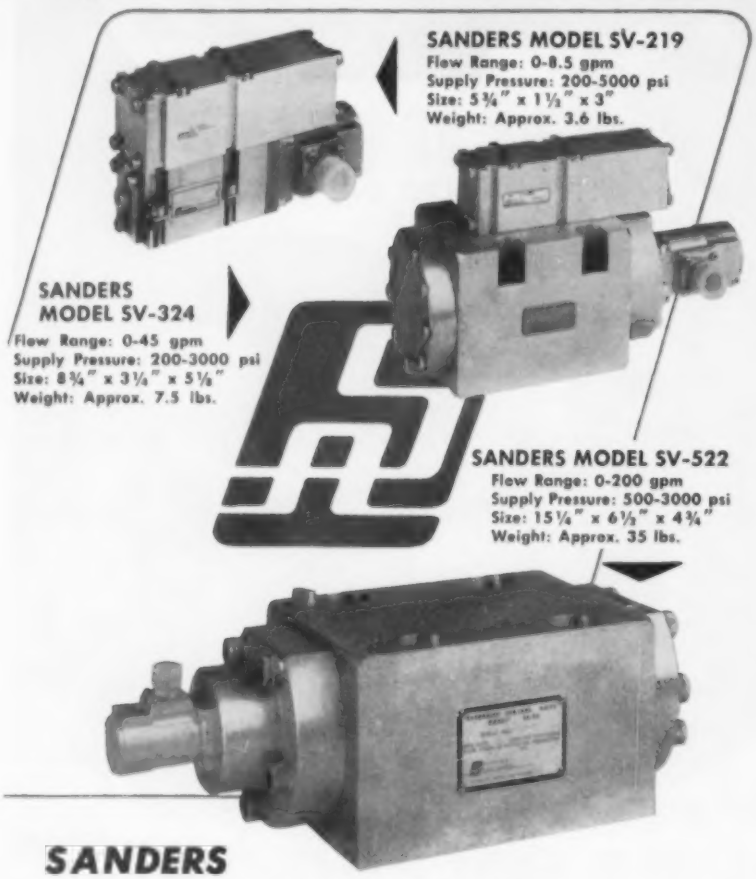
Send for complete new catalog on standard valves

DUKES Hydraulics

3999 North 25th Avenue • Schiller Park, Illinois • A Chicago Suburb

Circle **35** *on Time-Saver Card*

Simplest Approach to Automatic Control!



SANDERS

ELECTRO-HYDRAULIC SERVO VALVES

. . . flow ranges for all industrial requirements

Reliability-proved in industrial and military applications, Sanders BOOTSTRAP(T) Servo Valves simplify control systems by converting low electrical input into powerful hydraulic thrust. Available flow ranges, up to 200 gpm at 1000 psi ΔP, have been found ideal for controlling machine tools, structural testers, process control equipment and construction machinery.

Based on the "Bootstrap" two-stage, internal force feedback principal, versatile Sanders Servo Valves give you these advantages:

- High Internal Stiffness of Control
- High Frequency Response
- High Resolution and Low Threshold
- Large-Area Internal Pilot Filters
- Large Orifices and Nozzles

Get all the facts! Call on Sanders experience in developing and manufacturing complete electro-hydraulic control systems and major components. Our application engineers can provide unusual and effective solutions to your control problems. Write for specifications, prices and delivery schedules on Sanders Servo Valves.

SANDERS ASSOCIATES, INC.

NASHUA, NEW HAMPSHIRE • Dayton, Ohio • Inglewood, California • Washington, D.C.

Circle **95** *on Time-Saver Card*

BRIEFS

Hydraulic Expander Has 25-Ton Pull

Designed to form electric motor shells in many sizes, the expander is mounted on wheels to move from one machine or assembly line to another.

Expander is self contained and requires only connection to electrical power. Weighing less than

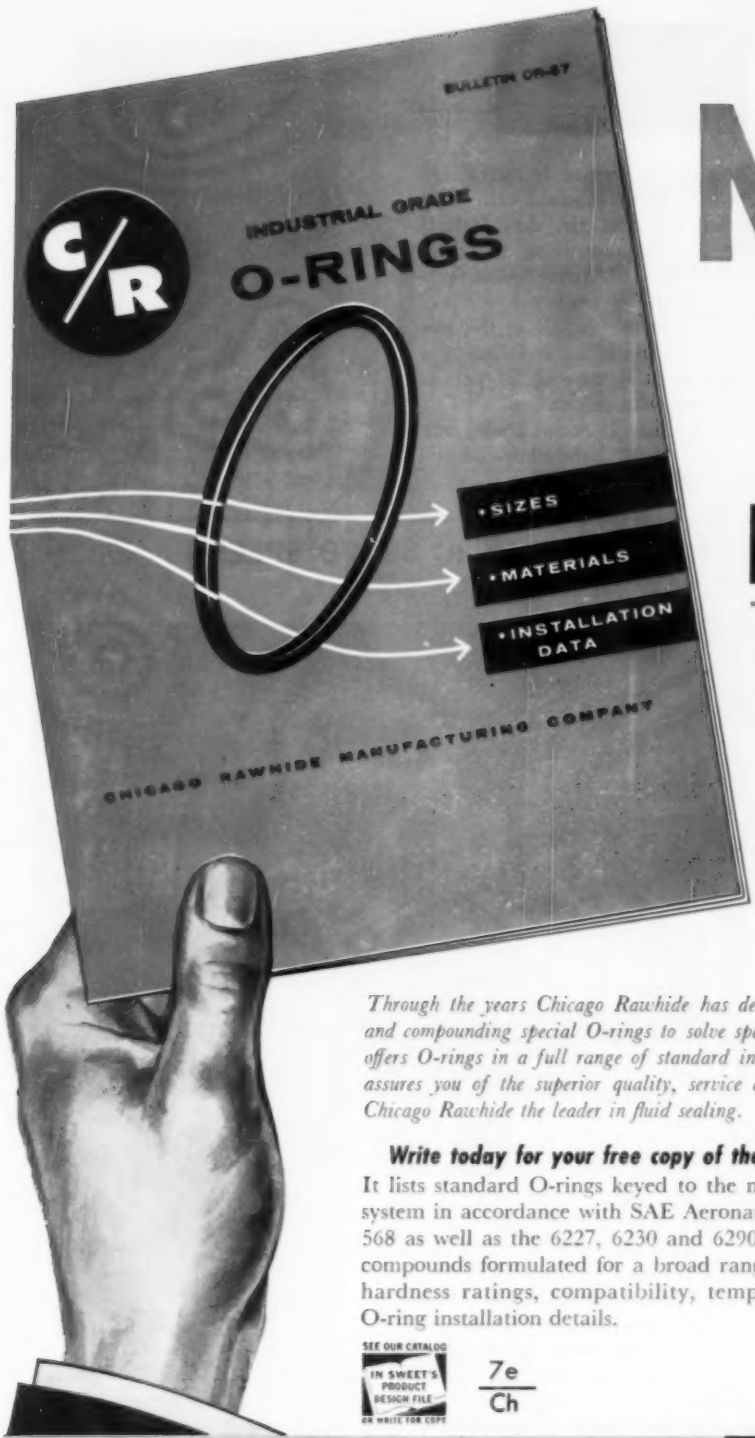
2000 lbs, it has a drawbar pull of 25 tons. By changing the hydraulic system and drawbar design, it develops 60 tons pull. Made by Grotnes Machine Works, Chicago, Ill. It handles inside diameters from 3½ to 16 inches with tolerances of ± .001-inch, and has automatic feed and eject mechanisms. The head has 12-jaws with removable wear shoes. □□□

Air Tests For Oil Leaks

This automatic leak testing machine will reject automatic transmission pump parts if they indicate a leak equivalent to one drop of oil per day at 200 psi. This amount of leakage can be sensed in 20 seconds during the test cycle.

• **Operation**—Part is placed in a two-section jig which is pneumatically clamped together. A short blast of high pressure air tests for blow-out. If there is no failure, an accurately regulated

Continued on page 32



NOW!

C/R Industrial O-Rings

in Standard Sizes and Compounds

Through the years Chicago Rawhide has developed a reputation for designing and compounding special O-rings to solve special sealing problems. Now, C/R offers O-rings in a full range of standard industrial sizes and compounds, and assures you of the superior quality, service and dependability that have made Chicago Rawhide the leader in fluid sealing.

Write today for your free copy of the new C/R O-Ring Bulletin.
It lists standard O-rings keyed to the new, uniform dash numbering system in accordance with SAE Aeronautical Recommended Practice 568 as well as the 6227, 6230 and 6290 series sizes. It also lists C/R compounds formulated for a broad range of industrial purposes with hardness ratings, compatibility, temperature ranges, and typical O-ring installation details.

SEE OUR CATALOG IN SWEET'S PRODUCT DESIGN FILE OR WRITE FOR COPY

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Ch

CHICAGO RAWHIDE MANUFACTURING COMPANY
1203 ELSTON AVENUE • CHICAGO 22, ILLINOIS
Offices in 55 principal cities. See your telephone book.

OTHER C/R PRODUCTS: C/R Shaft and End Face Seals • Sirvene (synthetic rubber) molded pliable parts • Sirvis-Conpor mechanical leather cups, packings, boots • C/R Non-Metallic Gears

O-RING C/R DIVISION
CHICAGO RAWHIDE

Portable Hydraulic Power Pumps
10,000 psi intermittent
6,000 psi continuous

exclusive rapid approach

No. 797-E-SA

No. 797 series
213 cu in. per min. at 10,000 psi

Extra-high-speed drive at high pressure. Applies to a wide range of hydraulic systems. Compact unit . . . pump reservoir, and control valve in one housing. Simply operated, 2-position control handle with advance and return positions. Available with 4-way valve for double-acting rams. Delivers 213 cu in. of oil per min at 10,000 psi with 3 hp a-c motor . . . 106 cu in. with 2 hp motor.

No. 797-G-SA is same pump powered with 4½ hp 4-cycle, air-cooled gasoline engine.

No. 798 series
28 cu in. per min.
. . . at 10,000 psi

Easily carried, high-pressure pump. Has exclusive fast approach . . . high volume, low pressure . . . automatic change-over to low-volume, high-pressure drive. Develops 6,000 psi continuous pressure, 10,000 psi intermittent. Choice of integral 2-way or 4-way valve. Built-in 115 - 230 V ¾ hp a-c motor. Also available with built-in 1.7 hp gasoline engine, universal or low-voltage motor. Write for illustrated data sheets.

ALSO A SELECTION OF HYDRAULIC HAND PUMPS AND VALVES

GREENLEE TOOL CO.
1775 Columbia Avenue
Rockford, Illinois

GREENLEE

Circle **47** *on Time-Saver Card*

BRIEFS

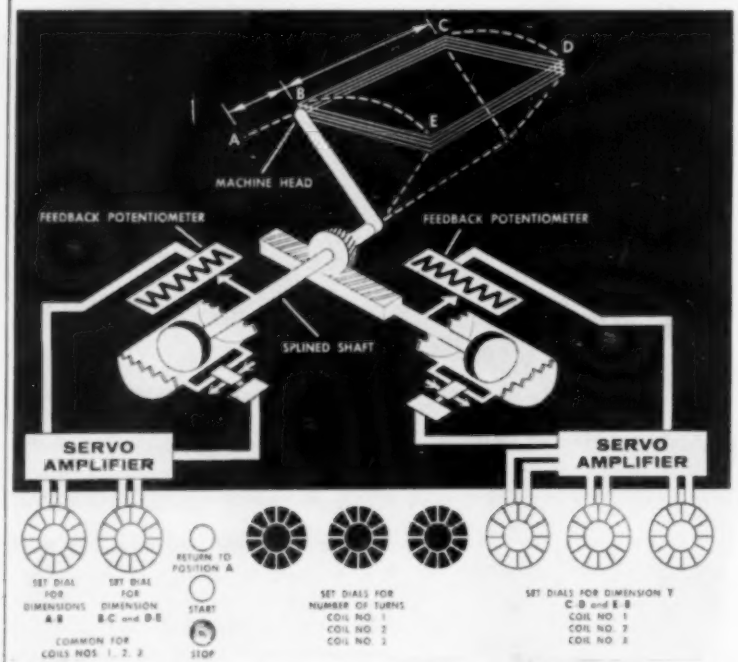
20-psi air pressure is introduced to the part. A solenoid valve then closes trapping air. Any leak is detected by measuring the pressure drop with a differential pressure cell which reads out to a sensitive pressure switch at the end of the cycle. If no leaks occur a green light lights and the part is automatically unclamped.

If leakage is above a set limit, a red "reject" light comes on and the part remains clamped.

The manufacturers, Cen Tec Corp., Livonia, Mich., can adapt the machine for testing porosity of castings, leakage through valves, and tank leakage. □□□

Continued on page 36

ELECTROHYDRAULIC SERVO SPEEDS COIL WINDING



System was designed for automating short-run production and offers a time-saving advantage of direct, uncoded programing for repetitive motion patterns.

The system illustrated operates a high-speed coil winder which produces three different motor windings with a single setup. Dimensions and number of turns on coils are programed by setting eight dials on a console. Dials control electro-hydraulic servo systems that position coil-winding machinery and operate the machine head which winds coils. System is simple to set up and operate. Variations in dimensions or sequence can be made immediately by resetting the dials.

The system, developed by Control Services, Inc., Hatboro, Pa., has a positioning speed of 0.2 seconds per basic motion with accuracy of 1 part in 1000.

Dimensions are infinitely adjustable, because a modulated rather than on-off signal is used. Systems are also made for contour programing. □□□

For Cylinders Circle **82** ➡
For Fittings Circle **83**

Bronze cartridge gland with "LIPSEAL"® and "WIPERSEAL" can be easily replaced without dismantling cylinder.

HANNIFIN

hydraulic cylinders proved best by drip-free test

Hannifin series "H" hydraulic cylinder with the only drip-free rod in the industry.

Select either "Step-Seal" piston rings (standard) for most applications or exclusive "LIPSEALS" where zero "clearance flow" is required.

No oil dripping on machine, product or floor proves complete sealing of oil within the cylinder by our removable, replaceable bronze cartridge gland with the exclusive "LIPSEAL"® and "WIPERSEAL" combination. (This new-type gland is shown close up at upper left.) This gland not only seals better, its long bearing surface is inside the seals where lubrication is assured.

Other Hannifin cylinder features include ground and polished rods hardened to an extra-deep case, then hard-chrome plated and polished again; cylinder walls "Tru-Bored" straight and perfectly round *before* being honed... PLUS 48-hour delivery on most standard Hannifin cylinders whenever required.

Your nearest Hannifin sales office or representative is listed in the A-Z volume of Thomas' Register. Call us in when cylinders figure in your designs. Or, for cylinder literature, write:

HANNIFIN COMPANY

515 South Wolf Road • Des Plaines, Illinois

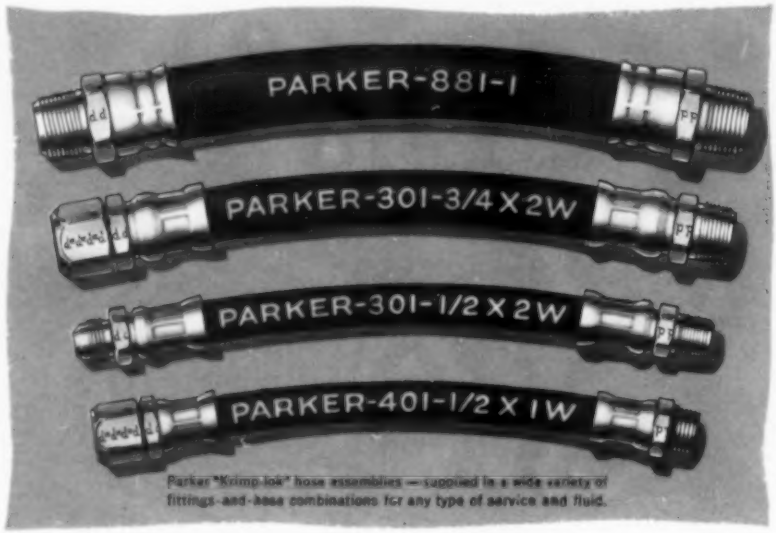
PARKER-HANNIFIN FLUID-SYSTEM COMPONENTS

Now from Parker

BOTH permanent-end

and re-usable

hose assemblies



Parker "Krimp-lok" hose assemblies — supplied in a wide variety of fittings-and-hose combinations for any type of service and fluid.

A few of the wide range of Parker adapters available

You may require permanent-end hose assemblies for your production AND re-usable fittings with coils of hose for quick, trouble-proof replacements in the field. With the addition of Parker's new "Krimp-lok" fittings, permanent-end assemblies are now available from Parker. They use the same Parker hoses that enjoy a wide acceptance when used with Parker *no-skive* "Hoze-lok" fittings in the replacement field.

A full range of Parker adapters is also available.

Ask your Parker Hose Distributor, listed in the Yellow Pages, for engineering advice and literature on "Hoze-lok" re-usable fittings, also Parker hose and adapters. Write us in Cleveland regarding your requirements for Parker "Krimp-lok" Hose Assemblies.

Parker

FITTINGS AND HOSE

DIVISION

17325 Euclid Avenue

Cleveland 12, Ohio

Parker "Hoze-lok" no-skive hose fittings and Parker hose, the ideal combination for short run production and quick, reusable field replacement.

A DIVISION OF PARKER-HANNIFIN CORPORATION

Do you know about Gask-O-Seals?

THIS Gask-O-Seal

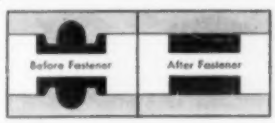
EXCEEDS HERMETIC SPECS!

Gask-O-Seals often equal or *exceed specification for hermetic* sealing. The one shown here, for instance, has eight sealing points and is on one of our newest missiles. The leakage rate is less than the original *hermetic* seal specification called for which is about as perfect as any seal can be.

Gask-O-Seals are high and low pressure static seals which require NO groove machining to accommodate. A flat surface with only a 125 RMS surface finish is all you have to provide to get positive sealing with a Gask-O-Seal.

There are many other outstanding features about Gask-O-Seals: Limited area for fluid attack, no loss of structural strength, rigid, easy to install and replace, no tolerance build-up possible in seal cavity, etc.

Why not find out about Gask-O-Seals and the other seals of Parker Seal Company's "O-Seal Family"—by the makers of Parker O-rings.



Parker
SEAL COMPANY
CULVER CITY, CALIF. • CLEVELAND, 12, OHIO
A DIVISION OF Parker Hannifin CORPORATION
(Formerly F. C. Wolfe Co. & Rubber Products Div. of Parker Appliance Co.)

Circle **84** *on Time-Saver Card*

Cup Seals

by

LINEAR

in Viton A, Vyram, Polyurethane, and other unusual elastomeric materials having excellent resistance to many petroleum oils, synthetic lubricants, fuels, phosphate and silicate ester fluids—in a temperature range of —40° to + 500°F.

LINEAR—specialists in close-tolerance molding in all of today's modern polymers . . . in both fabric reinforced and homogeneous materials.

These are low friction seals. For further help, call the LINEAR engineer.

"PERFECTION IN RUBBER"

LINEAR

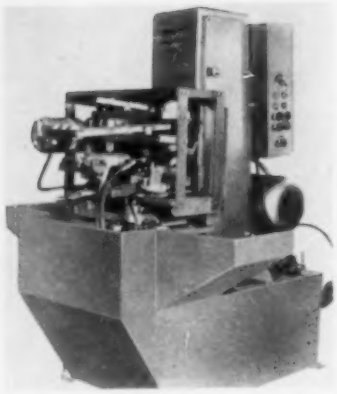
LINEAR Inc., STATE ROAD & LEVICK ST., PHILA. 35, PA.

Circle **70** *on Time-Saver Card*

BRIEFS

HIGH-SPEED precision rotor grinder uses a ¼-hp, 200-psi hydraulic power unit for table feed and oscillation, regulating wheel feed, and belt tensioning. Table has a rapid in-feed, and controlled belt-grinding feed. Designed by Engelberg, Inc., Syracuse, N. Y.

More Briefs on page 38



BRIEF NOTES

HEAVY END PIPE . . . Reynolds Metals Co. developed an aluminum pipe with increased strength and thickness at the ends where welded or threaded joints are made. Operating pressures are equivalent to standard pipe and cost savings range to 27%.

RESEARCH CENTER . . . to explore problems of flight to 10 times the speed of sound will be constructed by Lockheed Aircraft Corp. on a 198-acre sight near Saugus, Calif. The center will have a supersonic wind tunnel and complete aircraft test equipment including resources for hydraulic and pneumatic control studies.

NEW NFPA MEMBERS . . . The National Fluid Power Association has announced these new members: American Bosch Div., American Bosch Arma Corp., Springfield, Mass.; Hupp Aviation Co., Chicago, Ill.; Mayfair Industries Inc., Chicago, Ill.; Numatics Inc., Highland, Mich.; Oil-Dyne Inc., Chicago, Ill.; Versa Products Inc, Brooklyn, N.Y.

HIGH TEMPERATURE COATINGS . . . can be applied with a new plasma-arc torch developed by Linde Co., New York City. The process harnesses temperatures up to 30,000 F and can be used to coat any material with a wide variety of metallic or refractory platings.

AIR USES INCREASE IN CANADA . . . The increased use of air control components and systems was the subject of a talk given by Frank Meister of A. Schrader's Son, in Toronto. Uses and capabilities of compressed air, when and where to use air control, and components and their functions were demonstrated with an animated display panel.

BUSINESS BRIEFS

FOURTH PERIOD EARNINGS UP . . . Aeroquip Corp., Jackson, Mich. had net earnings in excess of $500,000 for the three months ending November 30. This compares with $896,458 for the full fiscal year which ended September 30, 1958. Orders on the books at the end of September were 14% over last year.

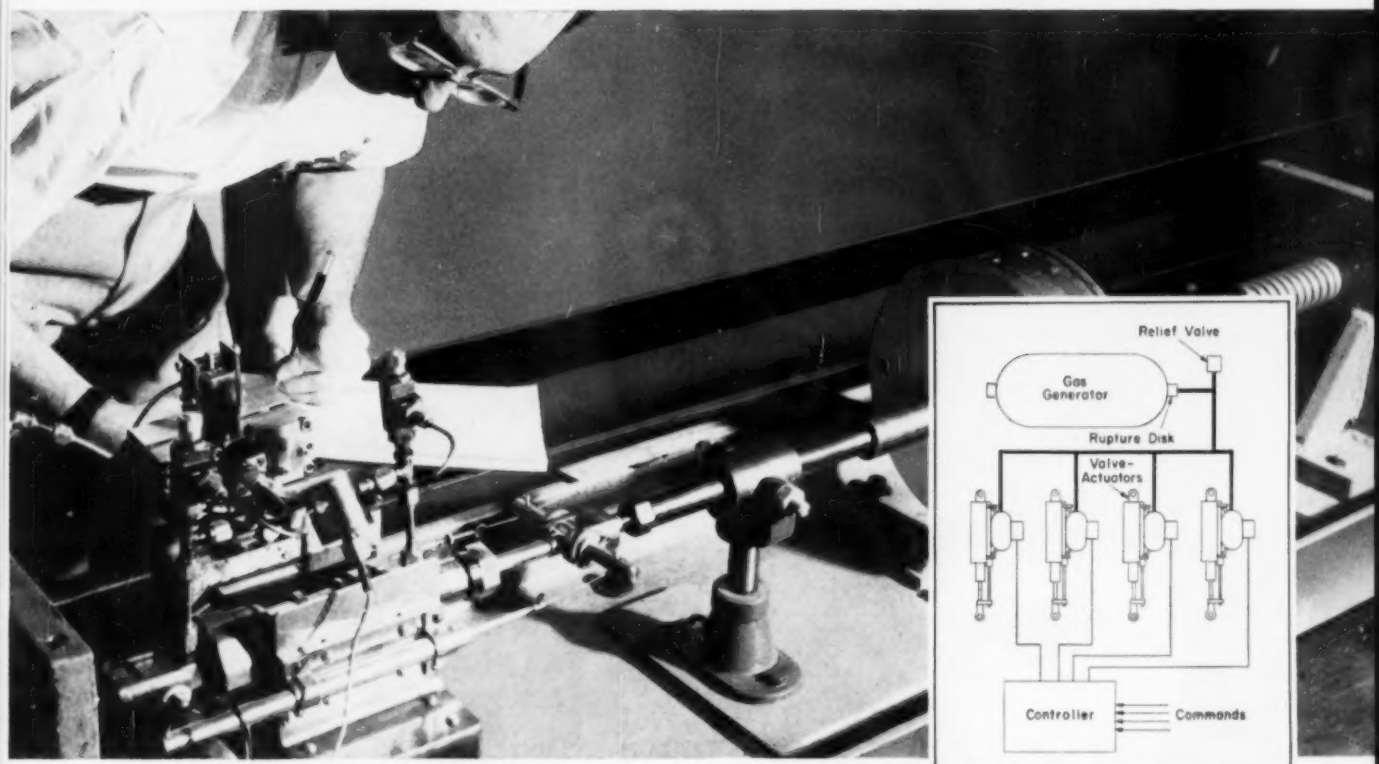
HIGH CAPITAL EXPENDITURES . . . for 1959 is the plan of Standard Pressed Steel Co., Jenkintown, Pa. H. Thomas Hallowell, Jr., president of the firm, stated that sufficient investment will be made in capital equipment to maintain the prompt deliveries, high quality, and good service customers received during the recession.

PRESSURE GAGE COMPANY PURCHASED . . . Ownership of Jas. P. Marsh Corporation and subsidiaries has been acquired by Colorado Oil & Gas Corp. of Denver, Colo. Marsh will retain their identity, personnel, and sales representation. W. C. Norman, president of Colorado Oil & Gas Corp., becomes chairman of the board, and A. D. Rose, former executive vice president of Marsh, is now president.

PLASTICS UP IN '58 . . . Tri-Point Plastics, Inc., Albertson, N.Y., announced an 80% increase in the demand for plastics last year. A major portion of the increase was in Teflon and Kel-F which the company machines to tolerances of 0.0005.

WHERE HYDRAULICS WON'T PERFORM . . .

GAS SERVO SYSTEM



Four-channel position system with common hot-gas generator, designed for thrust-vector control.

Ideal For High Temperature and Radiation Environments, G-E Gas Servos Are Compact—Give Fast Positioning Response

General Electric has developed a new gas servo device for actuation control systems where hydraulic servomechanisms are undesirable. Basically a force servo with position and velocity feedback, it consists of only three major components—an energy source, a valve-actuator unit, and a feedback and stabilization network.

By using the energy directly, rather than converting it to hydraulic power first, the system can tolerate ambient temperatures of 750F and higher. And, by eliminating this energy-conversion step, the number of components is kept at a minimum, simplifying the design, and thus increasing reliability.

As a hot gas servo, a solid propellant is stored in a gas-generating unit that also acts as an accumulator. When ignited, the gases fill the accumulator before entering the pressure-controlled, two-stage servo valve. The bleed-type first stage regulates the pressure in the second stage. This diverts the gas to either side of the actuator to control output force.

As a cold gas servo, with air or an inert gas as the energy source, the same system reduces contamination problems in high nuclear-radiation areas. In addition, the "closed-center" type valve also offers operating economies in such a system, when using stored gas or a closed cycle in which the gas is reused.

This servo system design offers several advantages over other approaches:

1. High frequency response is possible through pressure-type control. For example: 20 cps at 90-degree phase lag, with a 250-pound load. Higher response is possible with increased control bleed flow.
2. The unit is flexible. Damping, stiffness, and accuracy characteristics are controlled electrically. No change in hardware is needed.
3. Poppet valves minimize leakage. They have no close-fitting sliding parts and are well suited for high-temperature operation.
4. Symmetry of design lessens thermal shock problems, minimizes effects of G-forces, and avoids null shifting.

A dry system, the G-E servo eliminates virtually all the problems resulting from the static storage of liquids—thermal expansion, leakage, evaporation, etc. This reduces maintenance and insures instantaneous readiness.

If you'd like more information about G-E's gas servo and how it could help simplify your positioning-control designs, just fill out and mail the attached coupon, or contact your nearest General Electric Aviation and Defense Industries Sales Office.

Manufactured by General Electric's Aircraft Accessory Turbine Department, West Lynn, Massachusetts

Progress Is Our Most Important Product

GENERAL ELECTRIC

Section D231-22, General Electric Co.
Schenectady 5, New York

Please send me "Gas Servo System" Bulletin GEA-6846.

☐ Immediate Project ☐ Reference Only

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POSITION _____

COMPANY _____

CITY _____ STATE _____

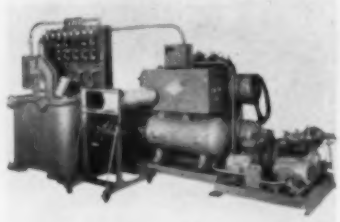
Circle **46** on Time-Saver Card

BRIEFS

Leaks Detected By Gas Analysis

Two, high pressure compressors are used to locate leaks in automotive air-suspension components. One compressor delivers 6.5 cfm of air at 800 psi for functional test, and the other compresses a 10% mixture of nitrous oxide and air to 375 psi for detecting leaks.

For the functional test, air cylinders force probes into the component ports. Automatic valving sequences the pressurizing of various chambers. At each test station the probes seal a different combination of ports.



For leak detecting, a 10% concentration of nitrous oxide is added to the air. Components are tested in a chamber. A vacuum pump draws air from the chamber and discharges it to a leak detector. If leakage is more than a preset limit a red light flashes and the operator rejects the part.

The gas analyzer detects a few parts per million of nitrous oxide. The machine was designed by Jered Industries, Inc., Hazel Park, Mich. □□□

BH EW

DOUBLE-ACTING GENERAL PURPOSE

Hydraulic Cylinders

3000 PSI SERIES

BHEW's 3000 PSI SERIES GENERAL PURPOSE CYLINDERS are designed around standard components, custom-built to suit the application. Flexibility in standard parts enables BHEW to supply a cylinder to fit most any application. Available in a variety of mountings, with or without adjustable or non-adjustable rod ends. Self-adjusting "V" packed rod glands and "U" cup seal on pistons.

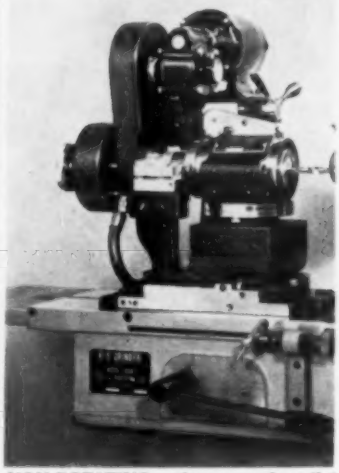
- Honed Steel Barrel.
- High Tensile, Hard Chrome Plated Rods.
- Packings available for extreme high and low temperatures and most non-inflammable fluids.
- A rugged 3000 PSI cylinder for OEM.

Tell Us Your Design or Application Problems. We'll Show You How to Solve Them.

WRITE TODAY!
FREE copy of Hydraulic Cylinder Engineering Reference Data Manual. Save hours of time in specifying cylinders. 78 dimensioned basic designs for general and special purpose double-acting cylinders.

BENTON HARBOR BH EW ENGINEERING WORKS, INC.
622 Langley Avenue St. Joseph, Michigan

Circle **19** *on Time-Saver Card*



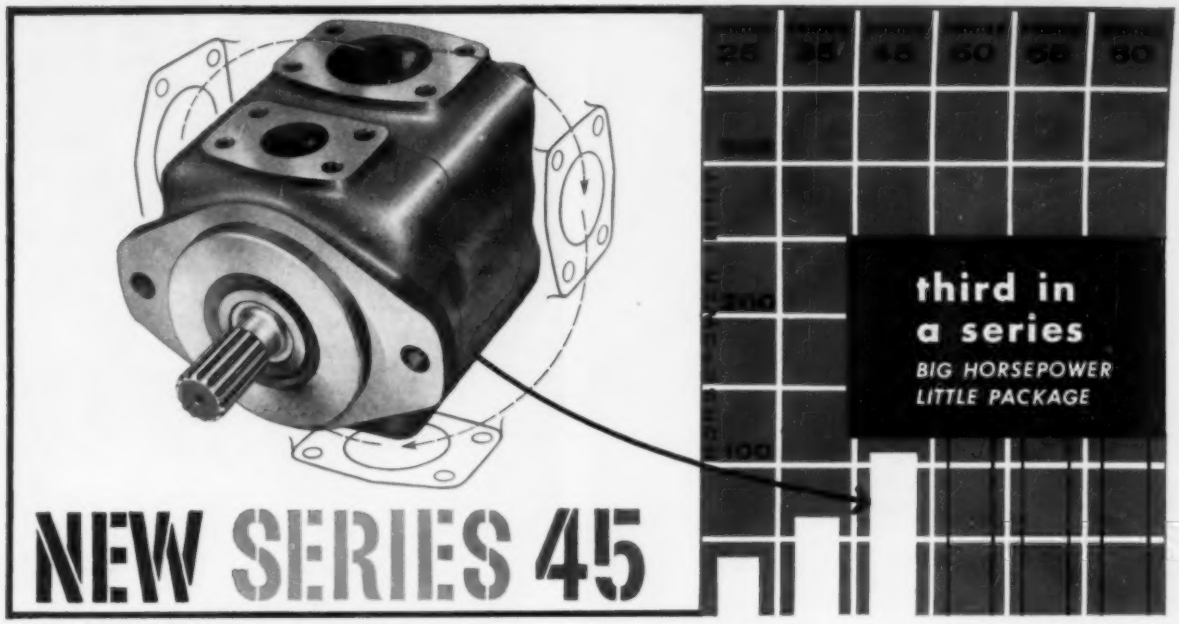
NON-ROTATING, air-powered collet closer for form relieving fixture speeds up tool changing and makes the machine useful for high-speed production sharpening. It operates on 60-psi air pressure. Collet actuator is double-acting and is operated from a foot valve. Royal Oak Tool & Machine Co., Royal Oak, Mich.

Feed Unit Uses Hydraulic Gripper

The 3-section unit feeds steel coils up to 40,000 lbs into blanking, piercing, or forming presses. Complete assembly consists of three units, a power-lift loader, a stock straightener, and a gripper-feeder.

The stock straightener uses air cylinders to raise the rolls for threading. The double-gripper-feeder uses a large-bore hydraulic clamp that is reciprocated along ground guide bars by a hydraulic

Continued on page 42



PATS. & PATS. PENDING

VICKERS "high performance" vane pump

• high speed • high pressure • high efficiency • high service life

NEW COMPACT DESIGN . . . much more horsepower than previous pumps of the same package size.

NEW VANE CONSTRUCTION . . . positive vane tracking at all operating speeds assures efficient operation at increased speeds and pressures.

NEW SIZES not previously available . . . answers mobile equipment designers' need for greater hydraulic horsepower in limited space.

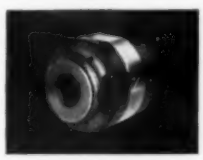
NEW PARTS INTERCHANGEABILITY . . . many common parts for single and double pumps (two pumps on the same shaft in one envelope). Lessens inventory requirements.

NEW 4-BOLT SAE FLANGE CONNECTIONS . . . will also accommodate user's 2-bolt flanges of the proper design.

NEW 2-BOLT MOUNTING (SAE 1959 STD.).

NEW 4-POSITION COVER . . . outlet can be rotated in 90° increments with respect to inlet.

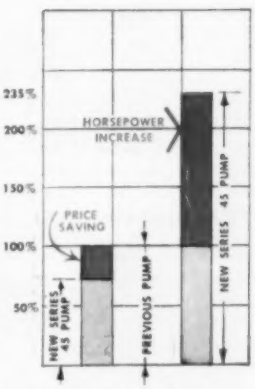
NEW REPLACEABLE PUMPING CARTRIDGE . . . all wearing parts of pump are incorporated in one replaceable cartridge. Easy field replacement without removing pump from its mount. Cartridges available in kit form.



MUCH MORE HORSEPOWER PER DOLLAR

The striking increase in horsepower per dollar of the Series 45 over previous pumps of the same delivery capacity is shown in the graph to the right. Maximum horsepower is more than double (235%) and price is lower by 35%.

This is the third unit released in the new complete line of "High Performance" Pumps, single and double. The first (Series 25) is available in 12, 14 and 17 gpm sizes and the second (Series 35) comes in 21, 25 and 30 gpm sizes (at SAE rating of 1200 rpm and 100 psi). This new Series 45 pump is available in 35, 42 and 50 gpm sizes.



The table below shows characteristics

Model Number	Delivery—gpm		Input Horsepower @ 2000 rpm 2000 psi	Package Size†	Weight
	1200 rpm 100 psi	2000 rpm 2000 psi			
2V35A-1*10	34	52	71	L. 7¼" W. 6¼" H. 6½"	69 Lbs
2V42A-1*10	41	63	86		
2V50A-4*10	48	75	103		

†Exclusive of Shaft Extension and Mounting Lobes

8201

Write for new illustrated Bulletin No. M5108 for further details and performance characteristics.

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
Mobile Hydraulics Division
ADMINISTRATIVE and ENGINEERING CENTER
Department 1474 • Detroit 32, Michigan

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IN CANADA: Vickers-Sperry of Canada, Ltd., Toronto, Montreal & Vancouver

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

Circle **111** on Time-Saver Card

Cut from 15-foot lengths, these cylinders must have exceptionally smooth interiors because of the patented rubber piston ring used by Gabriel.

The inner cylinders of completed shock absorbers are tested through more than 2,000,000 cycles on a machine which simulates typical road conditions.

J&L mandrel-drawn tubing meets unusual Gabriel shock absorber requirement

Special smooth cylinder interiors permit use of patented rubber-ringed pistons

Gabriel purchasing agent Eugene Kelley and chief engineer R. H. Whisler examine the critical inner cylinder of a standard shock absorber.

"We use J&L mandrel-drawn tubing because of its bore smoothness, its consistent uniformity, and the substantial cost reduction its use permits," says R. H. Whisler, chief engineer of Cleveland's Gabriel Company.

The key portion of their standard shock absorber is the innermost cylinder which contains the oil through which the piston moves. Gabriel has patented a special design for this cylinder's piston which uses a rubber O-ring instead of the piston itself to make contact with the cylinder's walls. Naturally, the cylinder walls used for this design must be especially smooth in order to assure long and trouble-free service from the rubber piston ring. J&L mandrel-drawn tubing fulfills this requirement completely.

Gabriel also uses J&L mandrel-drawn tubing in the manufacture of larger shock absorbers for trucks and buses—and for smaller shock absorbers for washing machines.

If your firm makes a product involving steel tubing with special smooth interiors, investigate J&L mandrel-drawn special smooth interior diameter (SSID) tubing. The cost reductions resulting from its use are often substantial. For more information, call your J&L representative. Or write to Jones & Laughlin Steel Corporation, 3 Gateway Center, Pittsburgh 30, Pennsylvania.

The exciting new J&L

Jones & Laughlin Steel Corporation

PITTSBURGH, PENNSYLVANIA

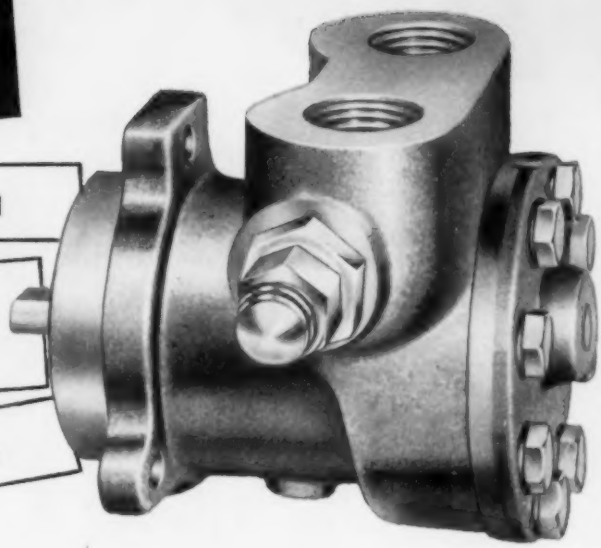
J&L STEEL

NOW

Compact design

Complete mounting interchangeability

Built-in relief valves



on TUTHILL small industrial pumps

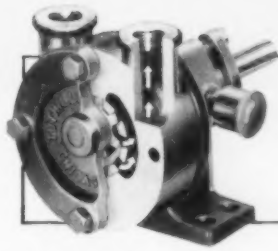
Now a new design—Series LPFV—gives you even greater flexibility with Tuthill small industrial pumps . . . the industry standard for dependable operation for many years.

Complete interchangeability allows the use of any one of five different sizes in the series on the same mounting arrangement. Capacities range from 20 to 360 gallons per hour, at pressures up to 500 psi. Normally provided for 1800 RPM, 3600 RPM speeds are permissible in most cases. And a built-in relief valve is now offered as optional equipment on all LPF models.

Compactness, an outstanding characteristic of all Tuthill pumps, is particularly exemplified in the new model LPFV with its shorter mounting hub. It is also available in close coupled motor-pump combinations for applications where space and weight are at a premium.

The newly designed model LPFV incorporates the performance-tested operating characteristics of Tuthill's internal gear construction described at right. In thousands of applications . . . in hydraulics, lubricating, transfer, circulating and other services . . . Tuthill internal gear pumps have established enviable records for reliability and quiet operation.

Over 700 models of Tuthill internal gear pumps are available to provide one especially suited to your application. These include stripped models for built-in applications, cartridge pumps, reversible models . . . a host of specialized pumps for each individual service. Mail the coupon today.



TUTHILL internal gear pumping principle

In Tuthill internal gear pumps, proven in 30 years of operation, there are only two moving parts. The principle is based upon the use of a rotor, idler gear and a crescent shape partition cast integral with the cover. Power applied to the rotor is transmitted to the idler gear with which it meshes. The space between the outside diameter of the idler and the outside diameter of the rotor is sealed by the crescent. As the pump starts the teeth come out of mesh increasing the volume. This creates a partial vacuum drawing the liquid into the pump through the suction port. The liquid fills the spaces between the teeth of the idler and the rotor and is carried past the crescent partition to the pressure side of the pump. When the teeth mesh on the pressure side the liquid is forced from the spaces and out through the discharge port.

Tuthill Pump Company
981 East 95th Street
Chicago 19, Illinois

☐ Please forward information on LPF series
☐ Please have your representative call

Name_____ Title_____

Company_____

Address_____

City_____ State_____

Tuthill Manufactures a Complete Line of Positive Displacement Rotary Pumps in Capacities From 1 to 200 GPM; for Pressures to 1500 PSI; speeds to 3600 RPM.

PUMPS FOR YOUR PURPOSE

TUTHILL PUMP COMPANY

981 East 95th Street, Chicago 19, Illinois

Circle **107** *on Time-Saver Card*

← *Circle* **64**

- **STRONG**
- **FLEXIBLE**
- **DURABLE**
- **ECONOMICAL**

This light, strong, flexible tubing meets stringent performance requirements at a fraction of the cost of metal tubing with required flexible couplings and intermediate fittings. And it is easier to install—saves assembly time. Available in 1000 psi and 2500 psi grades which conform to J.I.C. specifications for low and medium pressures.

Advantages include: high pressure rating at low cost; long flex and vibrational life; resistance to oils, greases, solvents; wide service temperature range; crush and abrasion resistance adaptability to standard metallic fittings.

Other feasible automotive applications are lubrication systems, fuel lines, oil lines, hydraulic systems.

For prompt service, contact one of The Garlock Packing Company's 30 sales offices and warehouses in the U.S. and Canada, or write

THE GARLOCK PACKING COMPANY,
Palmyra, N. Y.

United States Gasket *Plastics Division of* **GARLOCK**

Circle **108** *on Time-Saver Card*

BRIEFS

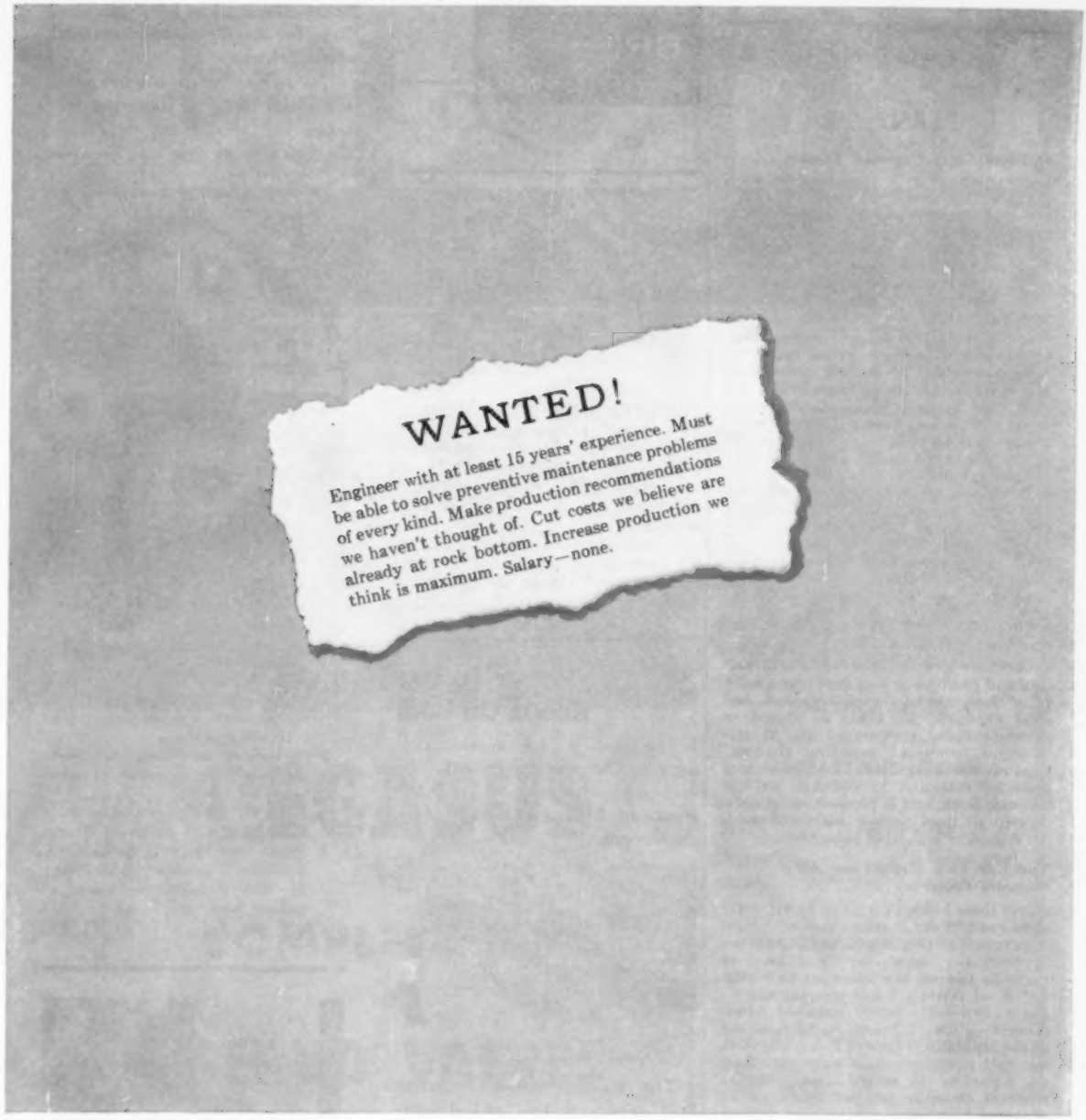
clamp that is reciprocated along ground guide bars by a hydraulic cylinder. The stroke can be varied in infinite increments by a screw adjustment.

Made by Sesco Inc., Detroit, Mich., the feeder is accurate and

entirely self-contained. It can be moved from one press to another. Simplicity in adjustment and operation reduce production downtime. It can feed from front, back, left, or right and may be attached to new or present equipment without re-working. □□□

Continued on page 44

BUTT WELDER is speeded up by using three air cylinders to operate the jaws. Cylinders are controlled by a quick-exhausting foot valve. Up to 2500 welds per hour can be made on both cold and hot-rolled metals. Equipped with air regulator, gage, oiler and filter. Alphil Spot Welder Mfg. Corp., Brooklyn 38, N. Y.


WANTED!
Engineer with at least 15 years' experience. Must be able to solve preventive maintenance problems of every kind. Make production recommendations we haven't thought of. Cut costs we believe are already at rock bottom. Increase production we think is maximum. Salary—none.

Mobil has the man . . . he's at your service!

There is a man who fits the above requirements to a "T". He's a Mobil lubrication engineer. His references include many of America's leading manufacturers. His thorough lubrication knowledge enables him to make preventive maintenance and production recommendations that can save thousands of dollars . . . *and actually have in hundreds of documented cases.*

He's at your service night and day when you select a Mobil Program of Correct Lubrication. Chances are you'll find his experience (over 17 years average), coupled with Mobil's comprehensive lubrication program, is an answer to today's continually rising production costs. Why not find out?

Mobil

CORRECT LUBRICATION

Another reason you're miles ahead with Mobil!

SOCONY MOBIL OIL COMPANY, INC., and Affiliates: MAGNOLIA PETROLEUM COMPANY, GENERAL PETROLEUM CORPORATION, MOBIL OVERSEAS OIL COMPANY, INC.

Circle **101** *on Time-Saver Card*

ADAMS FACT FILE #2

PLANT AIR

Moisture Chief Cause of Trouble . . .

Every company today is looking for ways to offset the increased costs of labor, material, equipment and services. At a gasoline station you expect "Free Air", but in industry it is a major expense. Perhaps in your own plant, for an investment in a few minor compressed air system alterations, significant savings are possible.

Water, sludge, rust, oil and dirt in compressed air systems are prime causes of maintenance and production down-time. Water vapor condensing in air lines tends to corrode the piping. Also, water present in the piping may freeze during winter, causing serious reduction of compressed air supply. Such restrictions are often difficult to locate and thaw. This same line moisture may emulsify lube oil destroying its lubricating value and the resultant mixture has high fouling characteristics. Frequently, ice will form within the tool itself since expanding air cools the moisture . . . tool efficiency will be seriously affected.

Some of the Other Problems Created By Wet Compressed Air . . .

Wet compressed air is not only a construction and production tool problem. Faulty paint jobs, contaminated chemical and food products can often be traced to moisture laden compressed air. Waterhammer, unequal pipeline thermal expansion and line leaks also result from collected moisture. In addition, air lost through traps, and in blow-down of compressed air lines provide no useful work . . . represent a sizeable power loss.

You Can Lick Compressed Air Moisture Problem . . .

All of these hidden costs can be virtually eliminated by the installation of an Adams Aftercooler and Cyclone Separator between the compressor and receiver tank. By cooling discharge air to within 10° F. of cooling water temperature — guaranteed with Adams standard Aftercoolers — the moisture can be removed at the separator. Pressure loss is less than one-half pound on these units including the separator. In severe cases, moisture removal of over 90 per cent can be obtained by cooling the air with Adams 2° Aftercooler to within 2° F. of water temperature.

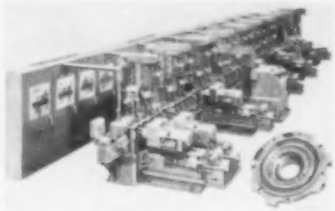
Air Filter for Final Protection at Point of Use . . .

As an added safeguard for expensive tools and equipment, an Adams Poro-Stone Air Filter should be installed just before the air is used. These filters remove all solid material picked up by the air stream. With an Adams Aftercooler, Cyclone Separator and Air Filters clean, dry, trouble-free air is supplied to your production tools. You get continuous service with minimum maintenance.

For further information on how the complete line of Adams air equipment can solve your compressed air problems, write today for your free copy of Bulletin No. 712 on Aftercoolers and Bulletin No. 117 on Poro-Stone Air Filters from the R. P. Adams Company, Inc., 249 East Park Drive, Buffalo 17, New York.

Circle **2** *on Time-Saver Card*

BRIEFS



TRANSFER MACHINE for transmission pump bodies uses standard quill-units, self-contained hydraulic power units to perform light-thrust operation. Each station is self-sufficient and has its own fixture with integral clamping. Quill units are mounted vertically on the fixtures. All hydraulic accessories are manifold mounted. Made by F. Joseph Lamb Co., Detroit, Mich.

Power Digger Keeps Oil Cool

Tractor-digger combination uses an electric fan-cooled heat exchanger that serves both the front-end loader and the digger attachment.

The air-to-oil cooler removes heat generated by hard digging and hot sun.

The exchanger fan is driven by a 6-volt motor. A resistor is added to the electrical system when the attachment is used on a tractor with a 12-volt circuit.

The unit is a product of Sherman Products, Inc., Royal Oak, Mich. □□□

Modular Test Stand For Servo Valves

Stand uses building-block design and has two separate test stand structures. Designed by Greer Hydraulics Inc., Jamaica, N.Y. for missile components and servo valves.

The first structure is a universal test stand with the following features:

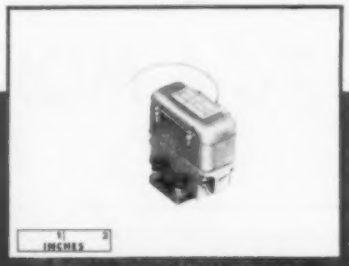
1. Flows to 19 gpm and pressures to 4500 psi.
2. Static pressure tests to 10,000 psi.
3. Separate pressure outlets for 3 simultaneous, independent pressure sources.
4. 4-way cycling valve.
5. Variable speed reversible hydraulic motor for testing hydraulic pumps.
6. Nominal 2-micron filters.
7. Heat exchanger to maintain 100 F oil temperature.

The second stand for testing servo valves uses the hydraulic supply from the first stand. Features of this structure include:

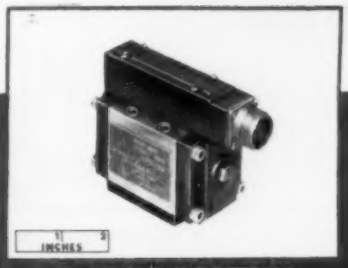
1. Signal generator for sine wave and square wave with amplitude from 0 to 100 cps.
2. Cathode ray oscilloscope for checking frequency response of servo valve.
3. Setup for static operation of servo with differential circuit of 60 ma.
4. Power and instruments to check insulation breakdown up to 2000 v dc, and dielectric resistance of coils to housing.

□□□

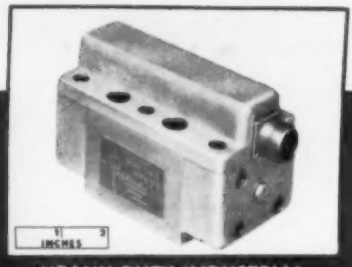
AIR OIL BOOSTER that raises pressure to 4500 psi simplifies piercing set-up. Basic unit is also used with presses for stripping or lift-out on the return stroke. Die-Draulic Grip, Inc., Grand Rapids, Mich.



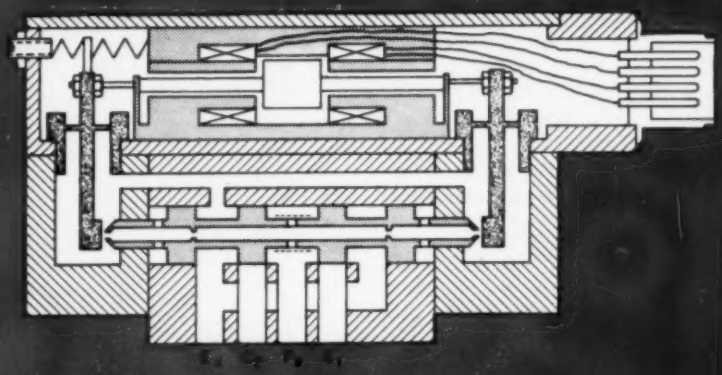
AIRCRAFT AND MISSILE



STANDARD INDUSTRIAL



HEAVY DUTY INDUSTRIAL



PEGASUS

The

COMPLETE LINE

of

SERVO VALVES

Also Available:

- A Standard Line of Instrumented Ram Actuators
- Adapter Manifolds for Piston Motors
- A Standard Line of Modular Servo Amplifiers

SPECIFICATIONS

AIRCRAFT AND MISSILE

Flows	.5 to 2 gpm
Size	Smallest in the industry
Material	Stainless Steel
Weight	.74 lb.

STANDARD INDUSTRIAL

Flows	1 to 160 gpm

HEAVY DUTY INDUSTRIAL

Flows	1 to 40 gpm

TWO SPEED SERVO VALVES

All valves are available with special lap which provides fine control around center and coarse control at the extremes of the flow curve. This provides both fine control and rapid traverse or slew rates in one valve.

PEGASUS LABORATORIES, INC.

DESIGNERS AND MANUFACTURERS OF ELECTRO-HYDRAULIC SERVOMECHANISMS

3690 W. ELEVEN MILE ROAD • BERKLEY, MICHIGAN

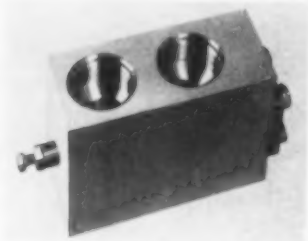
Circle **118** *on Time-Saver Card*

NEW PRODUCTS

Components, tools and equipment for fluid power systems. For more information fill in and mail post card bound in this issue.

CHECK VALVE
. . . is externally unloaded

Features: Precision made for dependability. Used in missile and ground support equipment. Spring loaded. Gives free flow in one direction and checks reverse flow

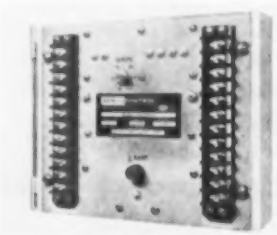


until an external plunger is depressed. Low internal leakage. No external leakage. Low pressure drop.

Specifications: Requires 100 lbs pressure to unload with 3000 psi being checked. Pressure drop is 65 psi at 25 gpm and 3000 psi in free flow direction. Proof pressure 4500 psi. Burst pressure 7500 psi.

Fluid Regulators Corp.
Painesville, Ohio
Circle **300** *on Time-Saver Card*

SERVOCONTROL POWER AMPLIFIER
. . . has all-transistor circuit

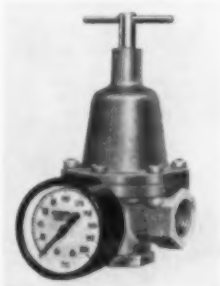


Designation: SC-AU20
Features: Amplifys one or more low power ac input signals (even less than one volt) to drive ac servo motors and dc torque motors, rated up to 5 watts. Diode clipping circuit protects amplifier against input current as high as 55 volts. Two transistors per stage increase reliability.
Specifications: Input impedance 2500 ohms. Input power 25 watts, 115 v. Linear gain control. Zero drift. Ambient temperature range —30 to 150 F. Weight 10 lbs.

The Oilgear Co.
Milwaukee, Wis.
Circle **301** *on Time-Saver Card*

AIR REGULATOR
. . . is self relieving

Designation: Diatrol
Features: Delivers accurately regulated air pressure without chatter. Built-in bleed valve relieves excessive downstream pressure. Made

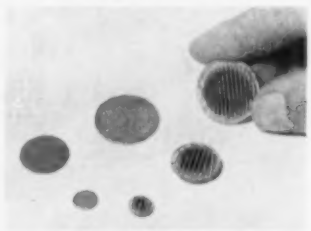


with thumb-screw or tamper-proof adjustment. Gauge can be mounted back or front.
Specifications: Gauge connections ¼-inch NPT. Pipe line connections ¼, ⅜, and ½-inch NPT. Operating pressure 10 to 125 psi.

Wilkerson Corp.
Englewood, Colo.
Circle **302** *on Time-Saver Card*

FILTER ELEMENTS
. . . for high temperatures

Designation: Poroloy 12380 & Poromesh 12420
Features: For hydraulic or pneumatic systems. Eight pore sizes from 5 to 250 microns. High flow rates with low pressure drop. With-



stand high pressure surges. Easily cleaned.
Specifications: Poroloy filters are made in 25 standard diameters from 0.067 to 1.2344-in and three thicknesses. Poromesh elements have five standard diameters from 0.375 to 1.368-in. Specials to order.

Bendix Filter Div.
Bendix Aviation Corp.
Madison Heights, Mich.
Circle **303** *on Time-Saver Card*

SEAL COMPOUND
. . . resists high temperatures

Designation: Vinton
Features: Retains elasticity for more than 2400 hours at 400 F and 1000 hours at 450 F. Resists new hydraulic fluids, lubricants, acids, and bases. Good resistance to ben-

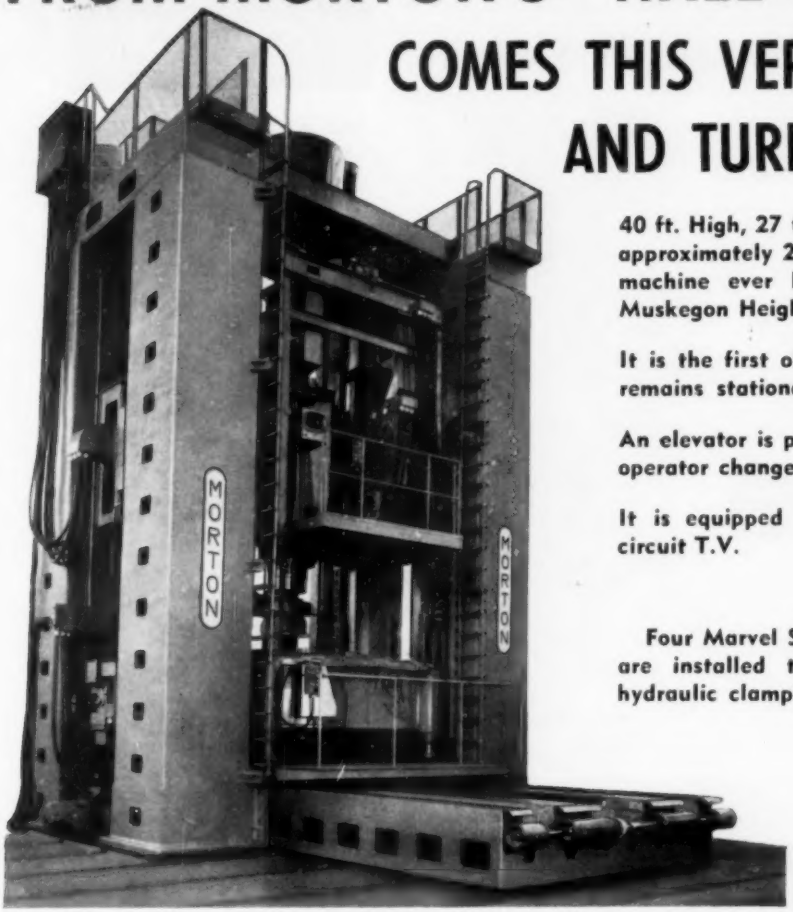
zene, carbon tetrachloride, acetone, and other solvents. Vinton O-rings operate at —65 F and resist compression set.

The Garlock Packing Co.
Palmyra, N. Y.
Circle **304** *on Time-Saver Card*

Continued on page 48

FROM MORTON'S "HALL OF GIANTS"

COMES THIS VERTICAL BORING AND TURNING MACHINE



40 ft. High, 27 ft. long, 22 ft. wide, weighing approximately 262,000 tons, it is the largest machine ever built by Morton Mfg. Co., Muskegon Heights, Mich.

It is the first of its type in which the work remains stationary.

An elevator is provided to help operator change tool heads.

It is equipped with a Closed circuit T.V.

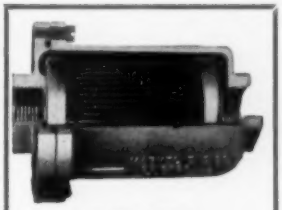
Four Marvel Synclinal Filters are installed to protect the hydraulic clamping circuits.

Photo Courtesy Morton Mfg. Co. Muskegon Heights, Mich.

SUMP TYPE
(Cutaway)

Like Morton Mfg. Co., who have relied on Marvel Synclinal Filters (continuously since 1950) to protect the hydraulic systems on their "giants", well over 800 other Original Equipment Manufacturers are installing Marvel Synclinal Filters as standard equipment on all machinery they manufacture, either stationary or mobile, utilizing hydraulic and other low pressure circulating systems.

When considering filters for dependable protection on your equipment, get the best — Get MARVEL SYNCLINAL FILTERS — the "giants" in filtering performance. They meet J. I. C. Standards.



IN-LINE FILTER

Handles up to 25 G.P.M. of hydraulic oil at very low pressure drop. Monel wire cloth filtering media in mesh sizes from 30 to 200. Cartridge is easily removed for cleaning.

A SIZE FOR EVERY NEED

Available for sump or line installation in capacities from 5 to 100 G.P.M. Greater capacities may be attained by multiple installation (as described in catalog). Choice of monel mesh sizes range from coarse 30 to fine 200.

EASY TO CLEAN

Both sump and line types are easily disassembled, thoroughly cleaned and reassembled, on the spot, in a matter of minutes. Line type operates in any position and may be serviced without disturbing pipe connections.

LINE TYPE
(Cutaway)

IMMEDIATE DELIVERY

Catalogs contain dimensional charts and complete engineering data making it easy to order a filter for your specific requirements and get Immediate Delivery.

MARVEL ENGINEERING COMPANY
7227 N. HAMLIN AVE.,
CHICAGO 45, ILLINOIS
Phone: JUNIPER 8-6023

Without obligation, please send me complete data on Marvel Filters, as indicated: (AH-2)

- ☐ Catalog #108—For Hydraulic Oils, Coolants, Lubricants
- ☐ Catalog #200—For Fire-resistant Hydraulic Fluids (Aqueous Base)
- ☐ Catalog #400—For Fire-resistant Hydraulic Fluids (Synthetic)
- ☐ Catalog #301—For Water

Name ..... Title .....

Company .....

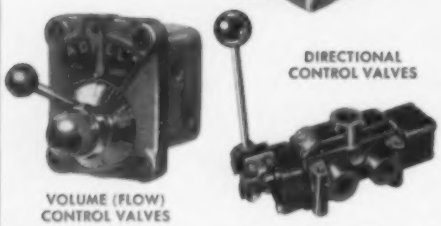
Address .....

City ..... State .....

ADEL *Reliability in Your Hydraulic Systems*

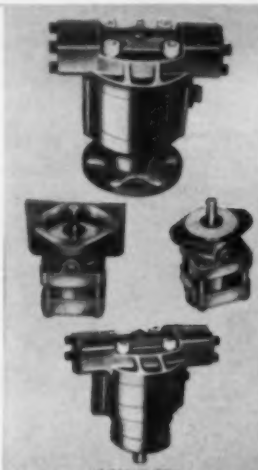
BETTER MACHINE CONTROL...
FOR BETTER MACHINE PERFORMANCE

PILOT OR SOLENOID OPERATED VALVES



DIRECTIONAL CONTROL VALVES

VOLUME (FLOW) CONTROL VALVES



GEAR-TYPE HYDRAULIC PUMPS

New Industrial Gear Type Hydraulic Pumps with capacities from ¼ to 35 GPM at pressures to 1500 PSI and speeds to 3600 RPM.

The diagrams show but two of innumerable circuits and systems where these versatile pumps and control valves can be used to advantage.

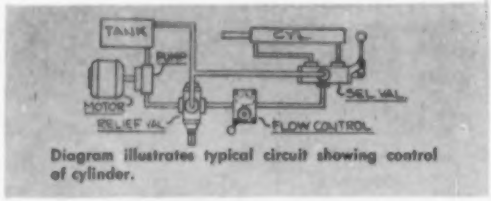


Diagram illustrates typical circuit showing control of cylinder.

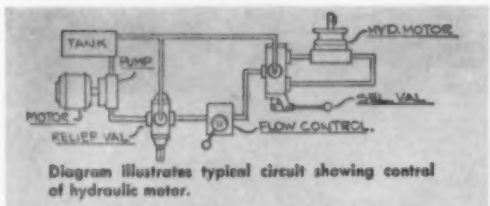


Diagram illustrates typical circuit showing control of hydraulic motor.

For metal working machines, industrial equipment, farm machinery, construction equipment, motor vehicles and marine applications... *Specify* ADEL *Precision-Engineered Hydraulics* for every mechanical operation in every industry.

Complete engineering specifications are available upon request.

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OHIO
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Milwaukee 17

Reliability
ADEL PRECISION PRODUCTS
A DIVISION OF GENERAL METALS CORPORATION

1444 WASHINGTON AVENUE, HUNTINGTON 4, WEST VIRGINIA

Circle **3** *on Time-Saver Card*

NEW PRODUCTS

AIR AND HYDRAULIC CYLINDERS
. . . have one-piece trunnion

Features: Easy adjustment of trunnion. Loosen tie-rod self-locking nuts and turn rods. Trunnion can be located anywhere along cylinder barrel. No clamping required. **Specifications:** Nine bore sizes from

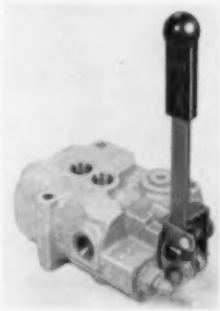
1½ to 8-inch. Cushioned or non-cushioned. Steel end plates and honed seamless steel barrels. Black oxide coated. Temperatures —20 to 150 F. Cushion check and adjustment are interchangeable.

S-P Mfg. Corp.
Cleveland, Ohio

Circle **305** *on Time-Saver Card*

DIRECTIONAL VALVES
. . . have low pressure drop

Designation: VDP
Features: Single spool gives good metering. Integral check valve prevents load drop when changing



spool position. Externally-adjustable, built-in relief valve. SAE straight thread O-ring ports. **Specifications:** Flow rates of 10, 20, and 40 gpm. Working pressure 2000 psi. Spring return to neutral. Spools balanced radially and axially.

Parker Hydraulics Div.
Parker-Hannifin Corp.
Cleveland, Ohio

Circle **306** *on Time-Saver Card*

Continued on page 52

NATIONAL OIL SEAL LOGBOOK

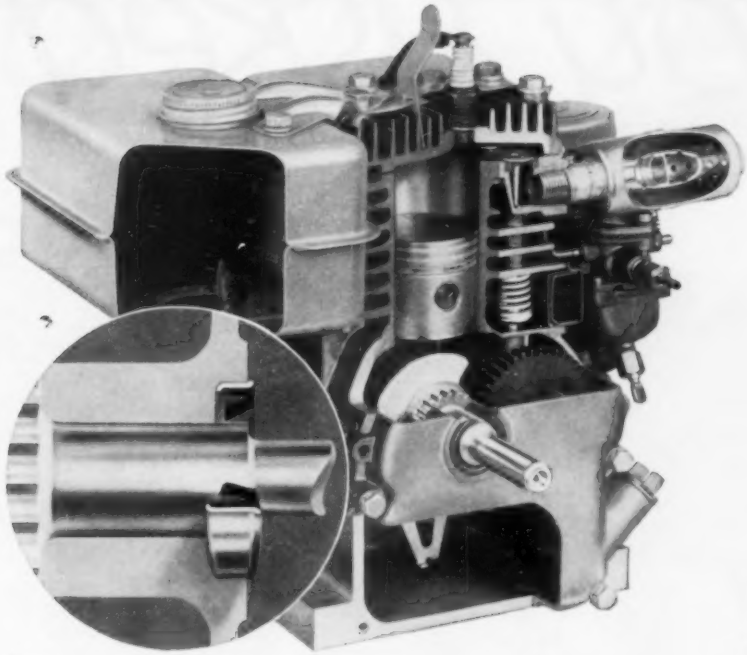


Figure 1.

Zero leakage oil sealing a "must" in Briggs & Stratton 2¾ hp engine

Some oil sealing applications can accept a small amount of lubricant leakage or "seepage." But not the Briggs & Stratton 8B Engine. Here, on a ⅞" crankshaft turning up to 3,600 RPM, light engine oil must be positively sealed in the crankcase at both front and rear bearing points. Oil temperature is 200° F with the engine at wide open throttle; and external temperatures may range from —30° to 125° F. Many Briggs & Stratton 8B engines operate only after long periods of inactivity; others are used continuously, a variable which makes the sealing problem even more demanding.

Satisfactory sealing and long, trouble-free service life is obtained by use of two special National Syntech® synthetic rubber seals (Fig. 1)—one at either sealing point. These precision made Syntechs have a minimum-contact sealing lip seating lightly but firmly on the shaft. The steel outer case is a precise press-fit for the bore, simplifying installation and preventing accidental working free of the seal.

National pioneered Syntech synthetic rubber seals; today offers a complete line of Syntech and leather seals plus convenient, competent oil seal engineering assistance. For data, for practical design help, call the National Seal engineer. He's under Oil Seals, in the Yellow Pages.

Variations on basic oil seal designs

10,000-S

Many modifications of the basic National spring-loaded Syntech oil seal design are offered. For example, where external conditions require a felt dust baffle, National 10,000-S may be employed. Where dirt or grit conditions are severe, a National 20,000-S with leather or Syntech auxiliary sealing lip is often used.

230,000-S

For applications where shaft entry is made from the auxiliary side, a National 230,000-S seal with auxiliary leather washer-type sealing lip mounted *in tandem* is suggested.

70,000-S

For positive separation of low viscosity fluids at higher speeds and temperatures, National 70,000-S series seals are suggested. Basically two 50,000-S seals mounted with sealing lips opposed, this seal may be used at temperatures above 250° F and speeds in excess of 2,000 FPM.

Altogether, National offers over 2,500 basic types and sizes. There is one best seal for a given application. Your National engineer can help you obtain it.

NATIONAL SEAL

Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California;
Plants: Van Wert, Ohio, Downey and Redwood City, California

Circle **77** *on Time-Saver Card*

You asked

Molded End Seals Reduce Cost

. . . eliminate costly machining. Special plastic impervious to all synthetic oils, mild acids, coolants, and water to 300° F.

One piece construction

No spare parts necessary. Positive protection against dirt, sludge, rust and abrasive particles causing pump failure.

Exclusive Radial Fin Design

Permits larger filter capacity in smaller area. Mesh screen supplied in 60 or 100 screen depending on efficiency desired and fluid viscosity.

for this new

DOLLINGER

SUMP FILTER

All new design — Two years ago Dollinger asked hydraulic equipment designers throughout the country what service conditions sump filters must meet, and what they should cost. As a result of that study, this new Dollinger Sump Filter was designed. It not only meets all your service requirements, but it is also lower in price than competitive filters! Already, leading hydraulic equipment manufacturers have standardized on this new filter for their products.

New low price — The drastically reduced cost of this Filter is the result of a new design which incorporates molded end seals. These end seals are made from a specially formulated plastic impervious to all synthetic oils at temperatures up to 300° F.

Eight standard sizes are available with capacities from 5 to 100 GPM.

Get complete facts now, write for New Sump Filter Catalog No. 330.
The Dollinger Corporation, 65 Centre Park, Rochester 3, N. Y.

PROTECTOMOTOR

STAYNEW FILTERS

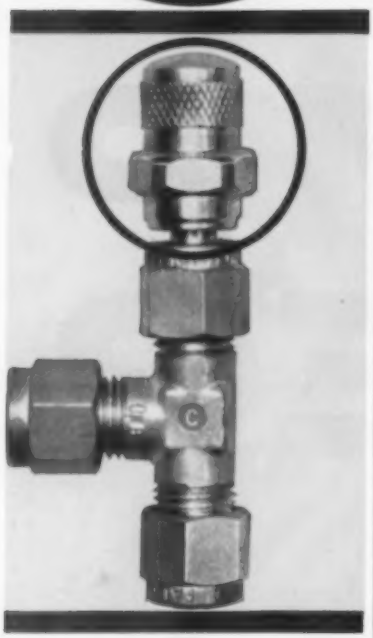
DOLLINGER

SPECIALIZING IN DRY TYPE FILTERS FOR OVER 35 YEARS

LIQUID FILTERS • PIPE LINE FILTERS • INTAKE FILTERS • HYDRAULIC FILTERS • ELECTROSTATIC FILTERS • MIST COLLECTORS • DRY PANEL FILTERS • SPECIAL DESIGN FILTERS • VISCOUS PANEL FILTERS • LOW PRESSURE FILTERS HIGH PRESSURE FILTERS • AUTOMATIC VENTILATION FILTERS • NATURAL GAS FILTERS • SILENCER FILTERS

Circle **34** *on Time-Saver Card*

The
NUPRO
Purge Valve
— offering NEW features for quick, easy, positive bleeding of gases or liquids from process or instrument lines



FEATURES

- Effluent removal passage directs gas or liquid away from operator
- Exclusive ball and seat design assures tight seal, yet prevents sticking
- One-half turn of cap gives maximum flow
- Knurled opening cap permanently attached to body
- Notch on cap indicates direction of discharge
- Cap opens easily

The NUPRO Purge Valve is available in brass, Monel, stainless steel, aluminum, Zytel* (nylon), Teflon*, and polyethylene. The range of materials, and the distinctive NUPRO features, assure dependable, long-time operation under all conditions, including highly corrosive applications.

Local distributors stock standard NUPRO Purge Valves with male and female pipe threads, AN connectors, Swagelok ends, and straight tube adaptors, in sizes from ⅛" to ½".

Write us for additional information.

Nuclear Products Company
15635 Saranac Road, Cleveland 10, Ohio
*Trade Mark, Dupont

NEW PRODUCTS

AFTERCOOLER
. . . with moisture separator

Designation: Type A-100
Features: Steel shell construction. Corrosion-resistant tube bundle. Packed floating head. Non-metallic baffles. Centrifugal moisture separator. Counter current flow for high heat transfer.
Specifications: Delivers air 10 to 15 degrees F above temperature of incoming water. Made in 54 models for pressures to 125 psi, single and 2-stage compression. Made special where needed.

American-Standard
Ross Heat Exchanger Div.
Buffalo, N. Y.

Circle **307** *on Time-Saver Card*

CONTROL VALVES
. . . are ball actuated

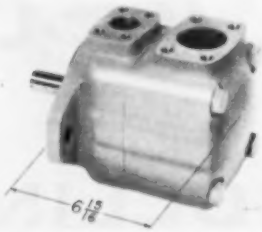
Features: Made in 3-way normally-open and normally-closed, and 4-way. Housings milled from aluminum bar stock. Valve plunger requires only ⅛-in travel to full open. Stainless steel valve plunger is radially ported. Manifolded by placing an O-ring between each valve. Eight valves can operate from one supply line. For air, water, and oil service. Have ⅛ or ¼-in pipe ports.

Hunt Valve Co.
Salem, Ohio

Circle **308** *on Time-Saver Card*

HYDRAULIC PUMPS
. . . with changeable cartridges

Designation: Series 35
Features: High horse power per dollar of cost. Hydraulically balanced for smooth operation. Capacity can be changed in the field by substituting another cartridge size.
Specifications: Speeds to 2000 rpm and pressures to 2000 psi. Three cartridges made for capacities of 31.5, 37.4, and 45.5 gpm at 2000 rpm. Port connections are SAE 4-bolt flange pads. Weight 50 lbs.

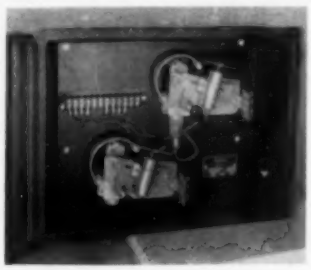


Vickers, Inc.
Detroit, Mich.

Circle **309** *on Time-Saver Card*

ABSOLUTE PRESSURE TRANSMITTER
. . . for pressures to 10,000 psi

Operation: Unit has two bourdon tubes; one sealed and evacuated to an absolute reference pressure, the other connected to line pressure. The armature of a differential transformer is connected to the bourdon tube. It sends out an electrical signal proportional to the pressure on the bourdon tube. The two differential transformers are wired together with their outputs bucking each other. A differential signal is transmitted for indicating, recording, or controlling absolute pressure.



Automatic Timing & Controls, Inc.
King of Prussia, Pa.

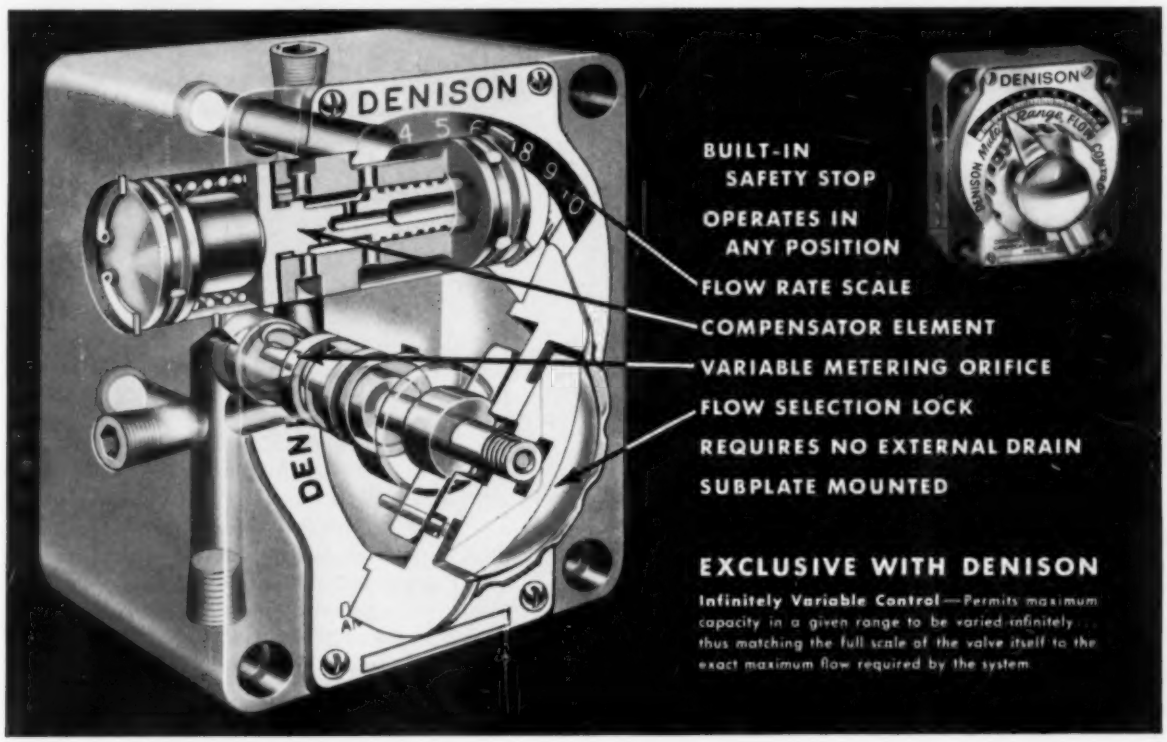
Circle **310** *on Time-Saver Card*

For more NEW PRODUCT reviews turn to page 122

NEW precision FLOW CONTROL at production prices

MULTI-RANGE FLOW CONTROL

- extra-sensitive flow control adjustment for precise flow settings
- temperature-viscosity compensated...no change in selected flow rate
- important exclusive design features now in all 3 sizes...¼"–⅜"–¾"



EXCLUSIVE WITH DENISON

Infinitely Variable Control—Permits maximum capacity in a given range to be varied infinitely . . . thus matching the full scale of the valve itself to the exact maximum flow required by the system.

Here's how to solve the problems of precise speed control . . . and uniform feed rate—for optimum precision work finish and cutter life for modern machine tool requirements.

With Denison's new Multi-Range Flow Control, you can count on these important exclusive design features and advantages . . . all pioneered through Denison advanced engineering—

PRECISE FLOW SELECTION is provided through a new, extra-sensitive control with an exceptionally wide range of adjustment in any given range.

MULTI-RANGE CONTROL—one model does the work of many to simplify inventory. Adjustments from range to range are simple, safe, foolproof—guarded by stops.

UNIFORM RATE OF FLOW is assured because Multi-Range Flow Control is virtually free from flow change due to temperature-viscosity changes.

FLOW SURGE OVERTRAVEL VIRTUALLY ELIMINATED—by simple adjustment—to avoid erratic feed of slides as the valve finds its setting.

BUILT-IN RELIEF VALVE saves space . . . simplifies circuits . . . may be remotely controlled.

BUILT-IN CHECK VALVE permits reverse free flow.

PRODUCTION PRICED . . . and built to JIC Standards for operating pressures to 2000 psi. Available in 2-port and 3-port types.

DENISON ENGINEERING DIVISION
American Brake Shoe Co.
1166 Dublin Road • Columbus 16, Ohio

MACHINERY DESIGNERS! ENGINEERS!

Write for full details and specifications in Bulletins VFC-3 and 143-A.

Denison, Denison HydrOILics and Multi-Range are registered trademarks of Denison Eng. Div., ABSCO

DENISON HydrOILics

HYDRAULIC PRESSES • PUMPS • MOTORS • CONTROLS

AIR VALVE

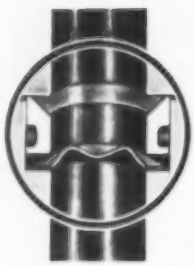
FOR ORIGINAL EQUIPMENT MANUFACTURERS

250 P. S. I. four-way air valves in ¼, ⅜ and ½ inch pipe sizes.

This is a re-design of our proven 250 P. S. I. air valve.

NEW FACE LIFT results in LOWER PRICE

None of the operating advantages of this rugged *'Shear-Seal'* valve has been reduced one iota!



. . . same non-corrosive construction throughout — eliminates failures due to rust.

. . . same long wearing leak-proof qualities — metal to metal *'Shear-Seal'* design is not sensitive to dirt, compensates for wear.

. . . same installation savings — because no oilers or filters are needed.

Only the exterior has been modified — tailored to the special preference of the Original Equipment Manufacturers — and, as a result, costs and prices have been substantially reduced.

Write for bulletin 5000 which includes design specs.

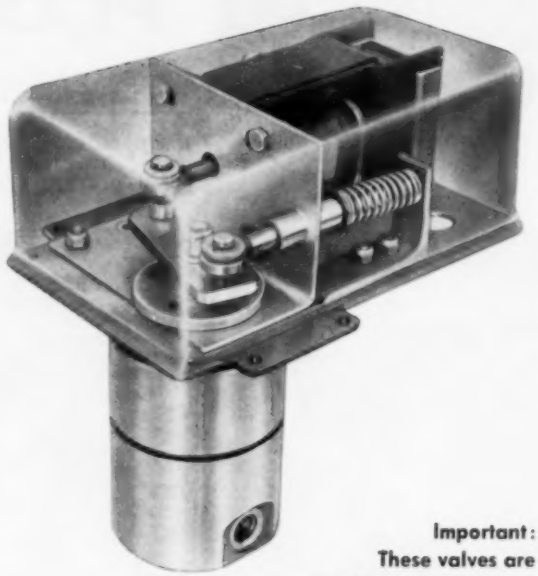
CONTROL VALVE DIVISION

Barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

Circle **15** on Time-Saver Card

10,000 P.S.I. SOLENOID VALVES



Important: These valves are standard catalog items.

● They are available for immediate delivery (in stock) at standard valve prices, for a service which generally requires costly (made-to-order) special valves.

● Shut off and 4-way valves in ¼, ⅜ and ½ inch port sizes are rated for 10,000 P.S.I. liquid or gases. They will withstand surges of up to 15,000 P.S.I. without damage to the valves' sealing qualities (designed for a burst pressure of 30,000 P.S.I.).
Solenoids are available for 115, 230 and 460 volt A.C. operation.

● Long maintenance-free service is achieved through the leak-proof "Shear-Seal" design. Optically flat metal to metal sealing surfaces (of the self-aligning sealing rings and the mating rotor face) are protected by staying in constant intimate contact: flow is always through the center of the "Shear-Seals," never across sealing surfaces. Sealing qualities actually improve as the seals lap themselves to a more perfect fit with each valve operation. There is no external shaft leakage because the pressure is confined to the flow passages.

For complete data write for catalog S-10000.

CONTROL VALVE DIVISION

Barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

Circle **16** on Time-Saver Card

interchangeable with all standard JIC cylinders

With the introduction of the ALL NEW T-J Squair Head, Tomkins-Johnson now offers industry the most complete design range of air and hydraulic cylinders. Presently available in bore diameters from 1½ to 8 inches, the T-J Squair Head is an interchangeable cylinder which produces maximum force and efficiency, with minimum pressures . . . and is also adaptable to the use of low pressure oil as the working medium. Write to The Tomkins-Johnson Co., Jackson, Michigan, for Bulletin #SQ 10-58 and complete details.

CHECK THESE 10 POINTS OF T-J SUPERIORITY

1 One Piece Piston

2 Hard Chrome Cylinder Bore and Piston Rods

3 High Tensile Steel Tie-Rods

4 Cushion Adjusting Screw, Externally Adjustable

5 New Super-Cushion for air, or Self-Aligning Master Seal for Oil (T-J Patents)

6 Solid Steel Heads and Mounting Plates Standard all Models

7 Port Design Allows Minimum Pressure Drop on Inlet or Outlet

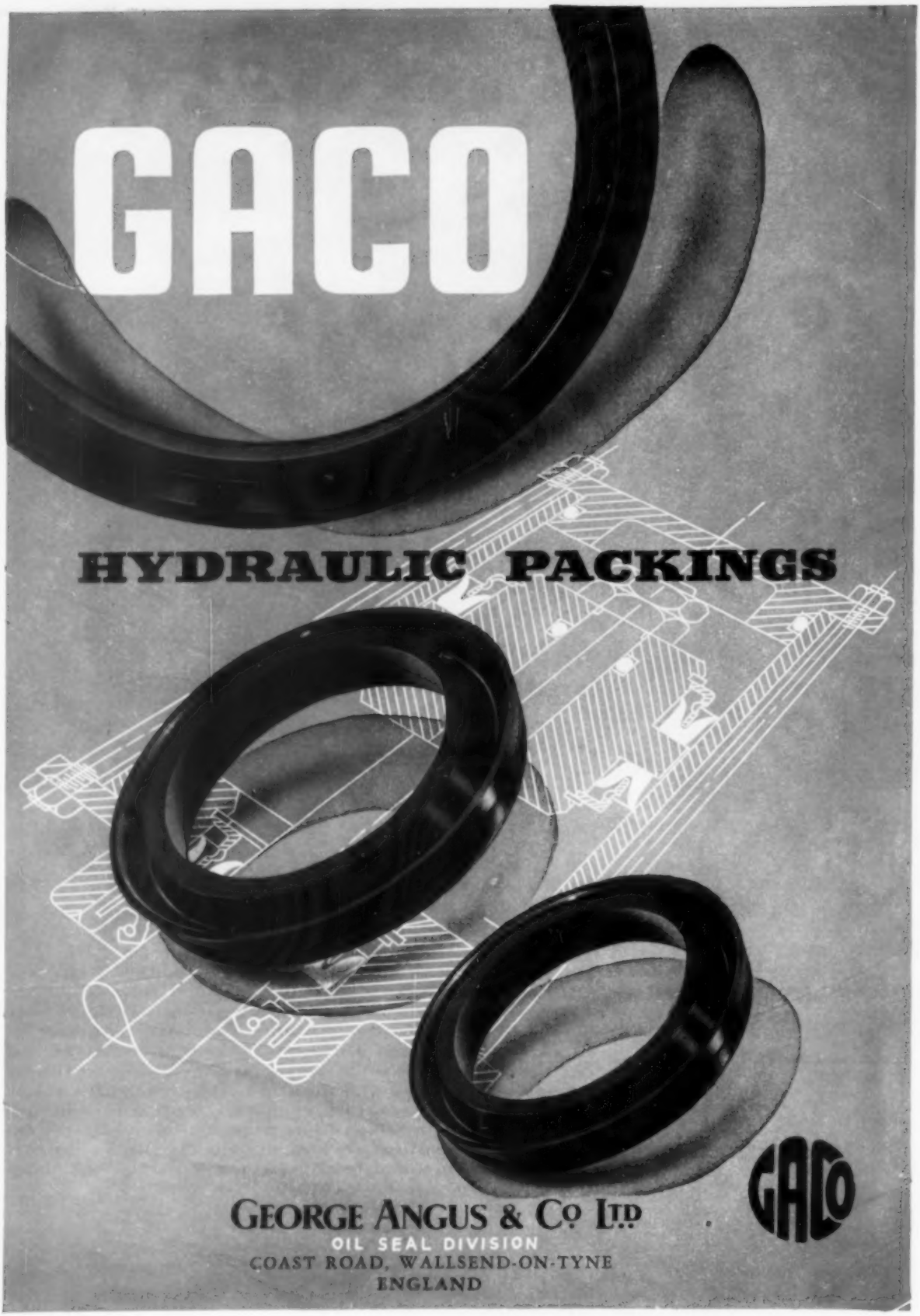
8 Chevron Type, Self-Adjusting Rod Packing

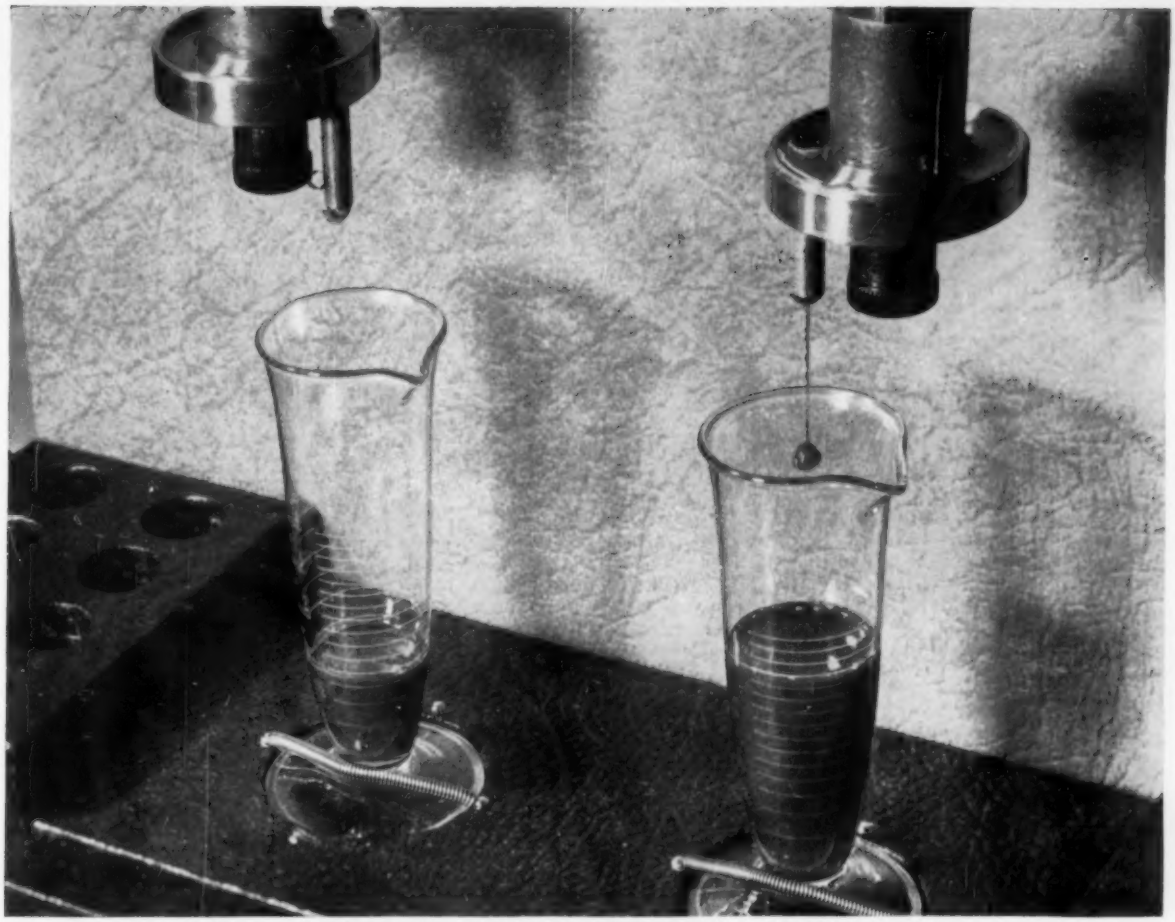
9 Piloted Packing Gland—Absolute Alignment

10 Piston Rod, Extra Strong—Polished and Chrome Plated for Efficiency and Protection

T-J TOMKINS-JOHNSON

Circle **106** *on Time-Saver Card*


GACO
HYDRAULIC PACKINGS
GEORGE ANGUS & Co LTD
OIL SEAL DIVISION
COAST ROAD, WALLSEND-ON-TYNE
ENGLAND
GACO



The oils collecting in these graduates are being forced, at 100 psi, through two sintered bronze bearings. Although each oil has the same viscosity, the Suntac on the left is leaking *only one quarter as much as* the straight oil on the right.

Desk-top demonstration proves that SUNTAC HYDRAULIC OILS can cut your oil losses . . . up to 75%

Suntac® oils are competitive in price, competitive in quality, *and unique in their ability to reduce oil leakage without costly shutdowns.*

Suntac oils are high-quality, exceptionally stable mineral oils especially compounded to reduce leakage. Experience proves that they give longer pump and seal life with higher overall operating efficiency.

See for yourself how a Suntac oil can cut your oil costs. A simple desk-top demonstration will show you how.

Ask your Sun man to show you how others have reduced oil consumption, or write to Dept. AH-2.

Industrial Products Department

SUN OIL COMPANY, Phila. 3, Pa.

SUNOCO®

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In Canada: Sun Oil Company Limited, Toronto and Montreal

USEFUL LITERATURE

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CONTROLLABLE CHECK VALVE

Requires low mechanical force to unload. Spring-loaded, it permits free flow in one direction and checks flow in reverse direction. For ground support and other exacting circuits. Detailed information and specifications. *Fluid Regulators Corp., Mentor, Ohio.*

Circle **400** on Time-Saver Card

AIR FILTERS

Single tube models for pressures to 4000 psi and flows to 800 scfm. Multi-tube models, with up to 270 filter tubes for higher flow rates. Tables and technical information on flow characteristics, physical dimensions, and materials of construction. *Commercial Filters Corp., Melrose, Mass.*

Circle **401** on Time-Saver Card

SERVOCONTROL

Valves, power amplifiers, and panels are covered in three separate bulletins. Valves have only two moving parts with no metal-to-metal contact. Amplifiers are transistor operated for low power input, (25 watts at 115 v ac). Control panels are custom made. *The Oilgear Co., Milwaukee, Wis.*

Circle **402** on Time-Saver Card

SWING JOINTS

Vinton-A O-ring seals. Pressures to 1000 psi and temperatures to 225 F. Two ball bearing races maintain alignment. Made of bronze, monel, aluminum, and steel. Complete dimensions on in-line and angle models. Grease fittings for lubrication. Eight pages. Catalog No. F-8. *Jordan Corp., Cincinnati, Ohio.*

Circle **403** on Time-Saver Card

PIPE & TUBE FITTINGS

Wall chart in easy to read form lists dimensions and installation instructions on over 50 different types of fittings. Flare, no-flare, and self-flare fittings in steel, stainless steel and brass are listed. *Flodar Corporation, Cleveland, Ohio.*

Circle **404** on Time-Saver Card

VALVES & FITTINGS

For fluid and gas handling at all temperatures and pressures. Dimensions and engineering data are given in tables and graphs. All types and sizes of the company's

line of valves, fittings, flanges, and unions are listed. 432 thumb indexed pages. Catalog No. F-10. *Henry Vogt Machine Co., Louisville, Ky.*

Circle **405** on Time-Saver Card

LIQUID SEALANT

Thin liquid plastic that hardens without shrinkage when confined between closely fitting metal parts. No heating required. Locks nuts to bolts and seals piping and tubing joints. Not affected by water, hydraulic fluids, or solvents. *American Sealants Co., Hartford, Conn.*

Circle **406** on Time-Saver Card

SOLENOID VALVES

For both ac and dc service in two and 3-way. Internal pilot operated to give full valve opening and low pressure drop. Pressures to 3000 psi in port sizes from ¼ to ¾-inch. Information arranged for easy selection. Twelve pages. Bulletin No. 2000. *Waterman Engineering Co., Chicago, Ill.*

Circle **407** on Time-Saver Card

HYDRAULIC PISTON PUMPS

High pressure axial for mobile and industrial use. Data on design, performance, displacement, horsepower, weight, installation, and application. Two pages. Sheet No. PF6006, *Dynex Inc., Pewaukee, Wis.*

Circle **408** on Time-Saver Card

FIRE RESISTANT FLUIDS

No corrosive effect on steel, brass, cast iron, aluminum, or copper. Cause no more wear on pumps than petroleum oils. High viscosity index, low pour point, and good shear stability. Tables cover viscosity, specific gravity, and test data. *D. A. Stuart Oil Co., Ltd., Chicago, Ill.*

Circle **409** on Time-Saver Card

HYDRAULIC POWER UNITS

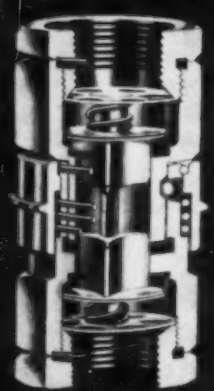
Pumps to 4 gpm at 1800 rpm and pressures to 3000 psi. Fibreglas reservoirs with 1½-gal capacity. Direct or belt drive. Motors for continuous or intermittent duty, ac or dc. Cut-away view with dimensions. *John S. Barnes Corp., Rockford, Ill.*

Circle **410** on Time-Saver Card

FORGED STEEL FITTINGS

Screw-end and socket-welded types in sizes from ⅛ to 4 inches. Meet ASTM specifications. Pres-

Continued on page 60



Provided with valves to give two-way or one-way automatic line shut off.

Built to handle high pressure in hydraulic and air systems.

Snap-Tite couplings stop the flow instantly"

Snap-Tite provides instant shut-off wherever fluid coupling is needed.

Snap-Tite couplings connect and disconnect quickly and fully—they automatically open line flow when connected; positively seal your line when disconnected—with no "ifs", no chance for human error.

Snap-Tite couplings are available in sizes from ¼" to 10" ID in all machinable metals. For more information, write for Snap-Tite catalog and, if you wish, describe your problem. Your local Snap-Tite representative will be glad to advise you.

SNAP-TITE COUPLINGS CAN HANDLE ALMOST ANYTHING THAT FLOWS

★ Snap-tite

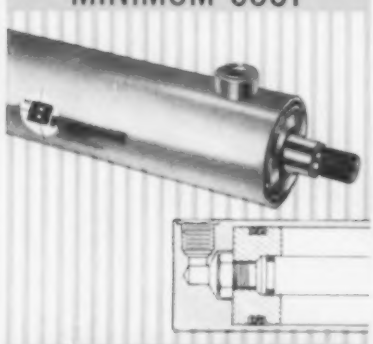
57-59-01

SNAP-TITE, INC. • UNION CITY 1, PA.

Circle **100** *on Time-Saver Card*

3000 PSI

MAXIMUM QUALITY
MINIMUM COST



DECCTO
CYLINDER

Save Weight—Space—Cost

Check these advantages:

- Clean, compact design.
- Exclusive "Bruning-ized" bore.
- Extremely wide selection of bores, rod diameters and mounting combinations.
- For both hydraulic and pneumatic applications.
- 3000 PSI operating pressure.
- Rugged, dependable performance.
- Easily adapted to customer specials.
- Premium quality.
- Highly competitive prices.

COMPARE PRICE AND DELIVERY

For original equipment or replacement parts specify Bruning DECCTO cylinders.

Bruning has a complete line of high performance hydraulic and pneumatic couplers, cylinders and check valves.

WRITE FOR FREE BULLETIN
No. 554-18

the BRUNING COMPANY

609 So. 9th St., Lincoln, Nebraska

Circle **20** on Time-Saver Card

USEFUL LITERATURE

sures to 6000 psi. Tables list weights and dimensions. Data section gives useful information on cross-sectional areas and flow rates. *H. K. Porter Co., Roselle, N. J.*

Circle **411** on Time-Saver Card

SNAP-ACTION SWITCHES

Complete details of nine housing groups of metal-enclosed

switches for industrial use. Explosion-proof, maintained-contact, pre-wired, hand-operated, and sealed switches. Actuator types to fill any requirement. Twenty pages. Catalog No. 84. *Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.*

Circle **412** on Time-Saver Card

DIAL THERMOMETERS

For temperature measurement from —40 to 1000 F. Specifications for both direct and remote reading. Information on the four types of filling mediums, case sizes, materials, and styles. Tables for selection of cases, bulbs, and bulb connections. Catalog No. 205. Twelve pages. *United States Gauge, Division of American Machine & Metals, Inc., Sellersville, Pa.*

Circle **413** on Time-Saver Card

CONTROL VALVES

Complete line including manual, electrical, mechanical, and pilot-actuated types ⅛ to 1-inch NPT. Valves for both air and hydraulic service are included. Pressures to 1500 psi. Dimensions and flow rates listed in tables. Valve speeds to 9 milliseconds. Eight pages. *Beckett-Harcum Co., Inc., Wilmington, Ohio.*

Circle **414** on Time-Saver Card

TUBULAR PRODUCTS

Fittings, flanges, and tubing made of stainless steel. Data on analysis, corrosion and oxidation resistance, high and low temperature characteristics, and physical and mechanical properties. Eight pages. *The Babcock & Wilcox Co., Beaver Falls, Pa.*

Circle **415** on Time-Saver Card

GASKET MATERIAL

Color-coded according to thickness. Colors are printed on a reference card for quick identification. Made of a tough plastic material that is not affected by oil or grease. Thickness from 0.001 to 0.030-inch. Made in roll and sheet form, or can be cut to size. *General Gasket, Inc., Middletown, Conn.*

Circle **416** on Time-Saver Card

PRESSURE GAGES

Cam and roller movement has no gear teeth to wear. Bourdon tubes of alloy steel, stainless steel, or K-Monel. Drop forged socket. Dial selection charts list all standard dials. Dimensions in table form. Pressures up to 20,000 psi. 32 pages. *Helicoid Gage Div., American Chain & Cable Co., Inc., Bridgeport, Conn.*

Circle **417** on Time-Saver Card

TEFLON HOSE

Springfield 400, finger-flexible hose, made in ¾ to 2-inch size. Bend radius is approximately three times diameter. Working pressures to 500 psi. Information on fittings and assemblies. Six pages. *Titeflex, Inc., Springfield, Mass.*

Circle **418** on Time-Saver Card

AIR CYLINDERS

VIH Series have directional control valve built into the head. Made with or without cushions in 1½, 2, and 3-inch bores. Stocked in strokes to 18 inches. Working pressures to 200 psi. Solenoids for any voltage. *Modernair Corp., San Leandro, Calif.*

Circle **419** on Time-Saver Card

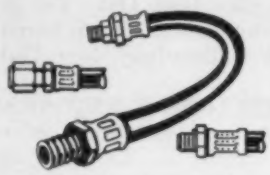
FLOW TRANSDUCER

Indicates, records, and controls flow of hydraulic fluids. High accuracy, fast response, and increased stability. All stainless steel. Electrical and hydraulic data given in tables and cross-section drawings. Four pages. *The Ramapo Instrument Co., Bloomingdale, N. J.*

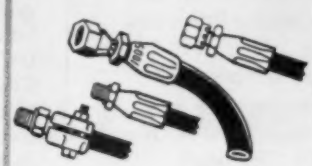
Circle **420** on Time-Saver Card

YOUR ONE BEST SOURCE FOR

Everything in Hydraulic Hose



FACTORY PRESSED-ON ASSEMBLIES—Standard hose assemblies or to your specifications.



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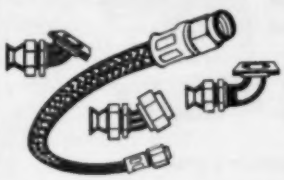

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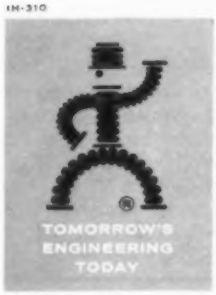

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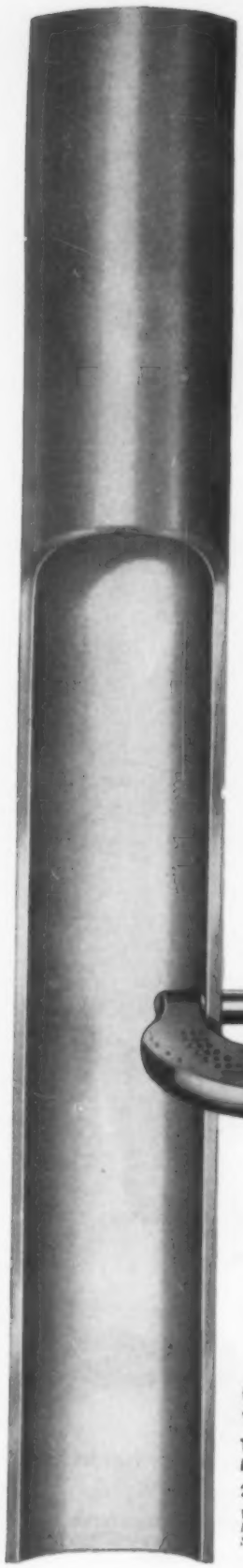

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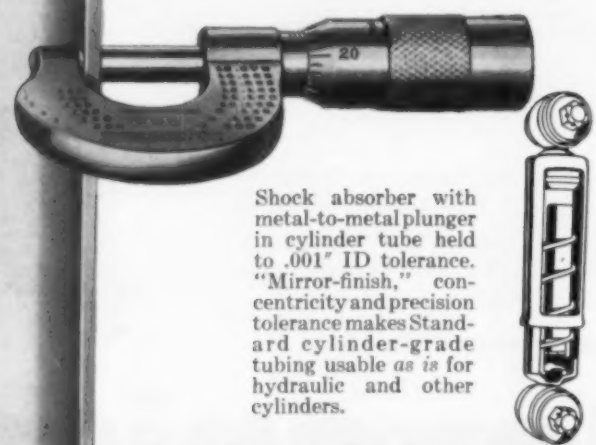

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FUTURE EVENTS

March 19-20: SAE National Production Meeting. The Sheraton - Cadillac Hotel, Detroit, Mich.

March 31-April 3: SAE National Aeronautic Meeting, Aeronautic Production Forum, and Aircraft Engineering Display. Hotel Commodore, New York, N. Y.

April 5-10: ISA Nuclear Congress, Cleveland, Ohio. For information contact Dr. S. Baron, 160 West Broadway, New York City.

April 14-15: Tenth annual Earthmoving Industry Conference. Peoria, Ill. Sponsored by Central Illinois Section, SAE.

April 27-May 1: SAE A-6 Aircraft Hydraulic and Pneumatic Meetings, Cleveland, O.

September 14-17: National Farm, Construction, and Industrial Machinery Meeting, Production Forum, and Display. The Ambassador, Los Angeles, Calif.

September 21-25: ISA 14th Annual Instrument-Automation Conference & Exhibit, International Amphitheater, Chicago, Ill.

October 5-10: SAE National Aeronautic Meeting, Aircraft Manufacturing Forum, and Aircraft Engineering Display. The Ambassador, Los Angeles, Calif.

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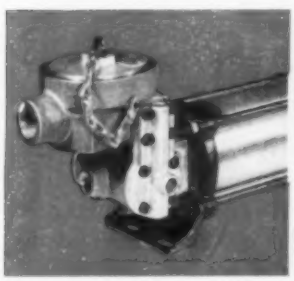

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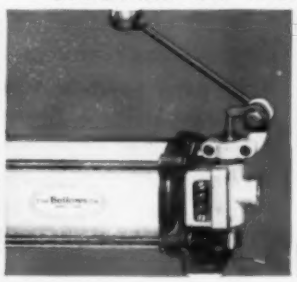

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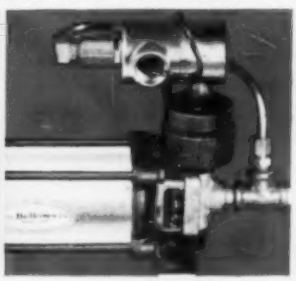

115 V. MAINTAINED CONTACT
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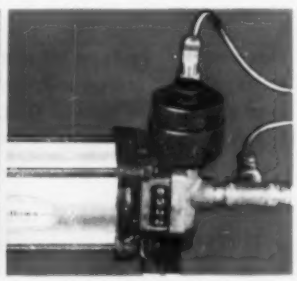

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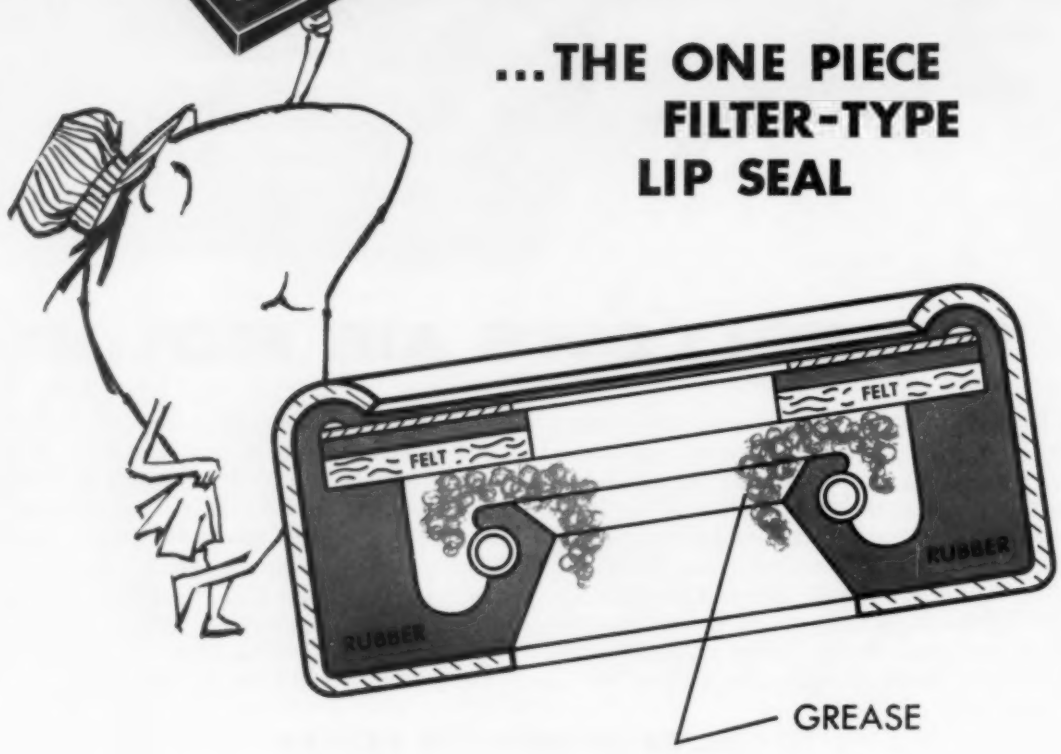

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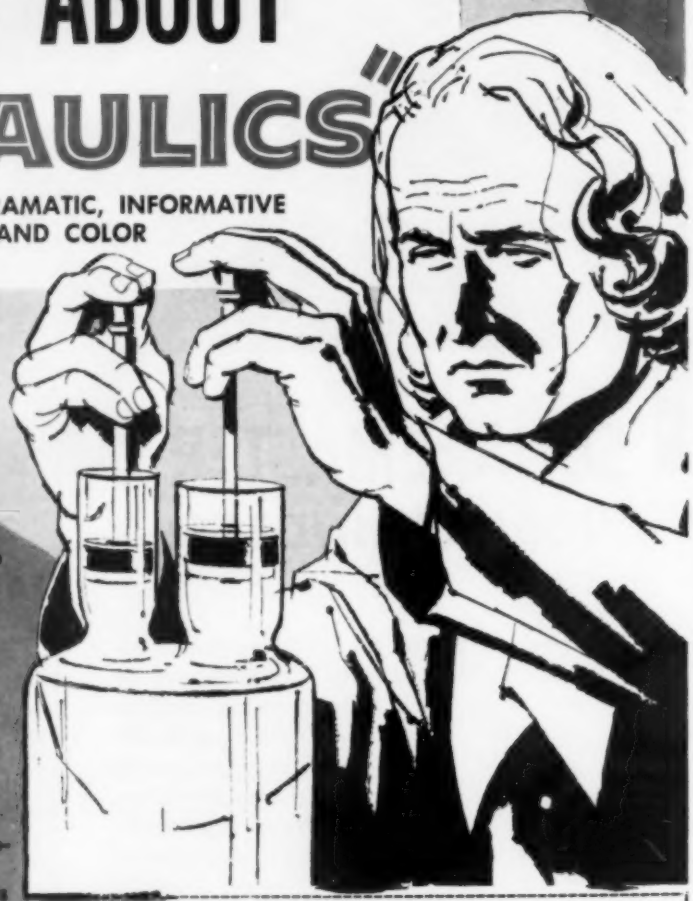

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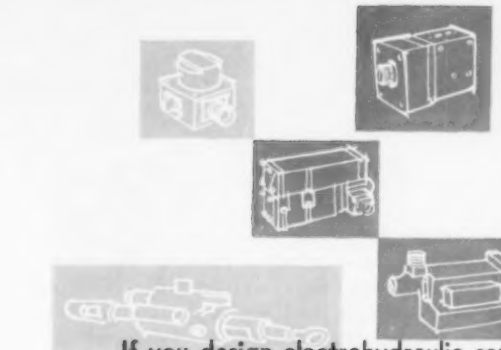


If you design electrohydraulic servo systems—whether they are for controlling electrodes in a furnace, machine tool slides, aircraft elevons, missile steering, submarine steering, or road grader blades—you need a transducer to give proportional control of hydraulic power. There's a wide variety of electrohydraulic servo valves being developed. This condensed information will tell you . . .

What you can get in electrohydraulic servo valves

● By WAYNE KINNEY and PHILIP WEISS, *Senior Engineers, Cook Research Laboratories, A Division of Cook Electric Co., Chicago, Ill.*

AN ELECTROHYDRAULIC servo valve takes a low energy electrical input and translates it into a proportional high energy hydraulic output. Most of the early designs, developed about 10 years ago, had an electric torque motor directly driving a spool valve. The torque motor armature was connected directly to the spool and supplied all power to move it. This is called a single-stage valve in contrast to later developments which added a second stage of hydraulic amplification or pilot operation.

Various designs have been used for the second stage. Cascading a second, larger spool valve with the first gives higher power levels. Feedback keeps output flow proportional to input signal. A 2-stage valve development that has been widely applied is the combination of a nozzle-flapper, hydraulic amplifier first stage and spool output stage. An electrical input signal produces a proportional output pressure from the hydraulic amplifier. This pressure drives the output spool. Restraining springs or internal feedback gives the proportional output.

• **Valve performance**—To select the best valve for your job, you've got to consider several characteristics or ratings that describe it. Even though ratings of two different valves may be similar, differences in their design and operation may make one better for your job than the other.

Performance of a servo valve is described by its static and dynamic characteristics. Important static characteristics are: maximum flow; supply pressure range; output flow or pressure per unit of input electrical power; linearity; threshold; hysteresis; internal leakage; weight; and size.

The torque motor may be sealed off from the hydraulic fluid (dry) or fluid may flow through the motor (wet). In a third type, the torque motor cham-

ber is filled with oil but there is no circulation. This is called stale design and has the advantages of cooling the motor without carrying contamination to it.

For many applications, a valve's dynamic characteristics in terms of transient or frequency response must be considered. Knowing the transfer function (mathematical relation between output and input) for each component of a system, you can predict system response. Because of many nonlinearities, no transfer function has been developed to describe a servo under all conditions.

If you consider only relatively small inputs, in the order of 25% rated current, linear techniques are adequate. Servo valves with an output flow proportional to input differential current can be approximately described in a limited frequency range by a single, first-order time constant:

$$\frac{Q}{\Delta i} \simeq \frac{1}{1 + j\omega T}$$

cascaded with a second transfer function that describes combined operation of the valve's output spool and system load. When operated with a load, a valve's response is dominated by load characteristics. These are mass, oil compressibility, viscous damping of the system, and spring constant of the load. When the resonant frequency of this combination is high, the no-load time constant of the valve may attenuate response.

Many non-linearities must be considered for a more exact analysis of valve operation, and then a single, first order time constant does not describe the dynamics at all frequencies. When curve fitting techniques are used to determine a valve's transfer function, a critically damped second order transfer function may be more nearly correct. However in practice, the first order time lag approximation is usually adequate.

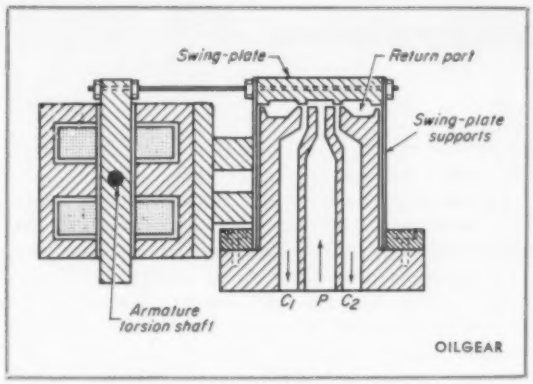
DESIGN 1 SINGLE STAGE

A torque motor drives the output spool through direct mechanical connection. Three-way or four-way spools, usually with near-zero lap, are used. Torque motor force must move the spool against flow and stiction forces. These valves usually have spool restraining springs to maintain output flow as a linear function of input current.

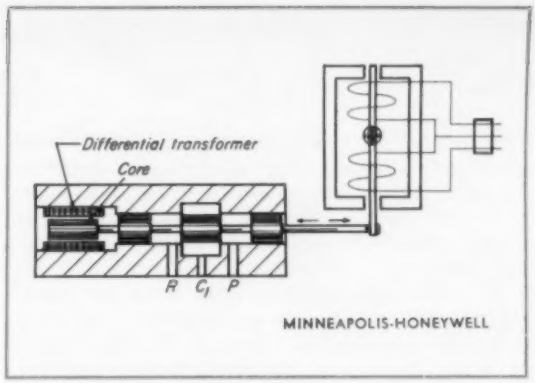
The low leakage characteristic of a spool and sleeve with small diametral clearance is an advantage of this design. However, relatively high forces are required. Consequently a large torque motor is needed. Small particles in the oil can make the spool stick.

Manufacturer	Model	Max. Flow Rating[1] (gpm)	Frequency at 3 db down or 90° Phase Shift[2] (cps)	System Pressure (psi)	Torque Motor Power (mw)	Torque Motor Type	Max. Internal Leakage (gpm)	Weight (lb)
AMERICAN MEASUREMENT & CONTROL	200	2.0	300	3000	6100	Wet	0.045[4]	2.3
	220	5.0	150	3000	4000	Wet	0.05	2.5
BENDIX AVIATION, HAMILTON DIV.	A07A	0.2	450[3]	100–1500	800	Dry		0.94
LEAR, LEAR-ROMEC DIV.	5214	1.0	300[3]	200–3000	600	Dry	0.05	0.75
MIDWESTERN INSTRUMENTS	3	6.7		200–3000	1600		0.3	5.0
	4	2.9		200–3000	2700		0.15	2.8
	7	0.9		200–3000	2700		0.13	2.3
MINNEAPOLIS-HONEYWELL REGULATOR, MACHINE CONTROLS DIV.	VJ 300[5]	9.0	350[3]	50–1000	4000	Stale	0.4	4.5
	VJ 302-7[5]	5.0	350[3]	50–1000	4000	Stale	0.4	4.4
	VJ 302-8[5]	1.5	350[3]	50–1000	4000	Stale	0.4	4.4
	VJ 303-3	4.0	350[3]	50–1000	4000	Stale	0.02	4.7
	VJ 303-4	2.0	350[3]	50–1000	4000	Stale	0.02	4.7
	VJ 303-5	1.0	350[3]	50–1000	4000	Stale	0.02	4.7
OILGEAR	SC-VP10-001	2		500	5000			4.5
	SC-VP10-002	8		3000	5000			4.5

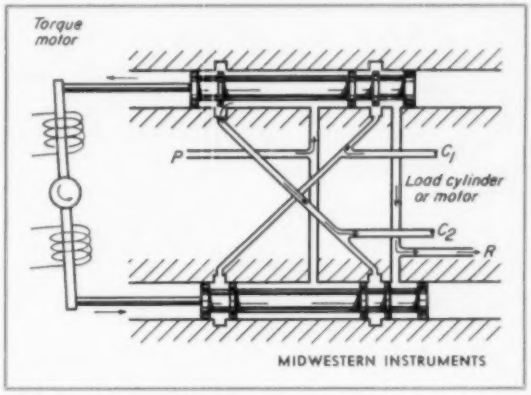
[1] 1/3 rated supply pressure across valve. [2] Average value under no-load conditions. [3] For 90° phase shift point only.
[4] With 250 psi across valve. [5] 3-Way.



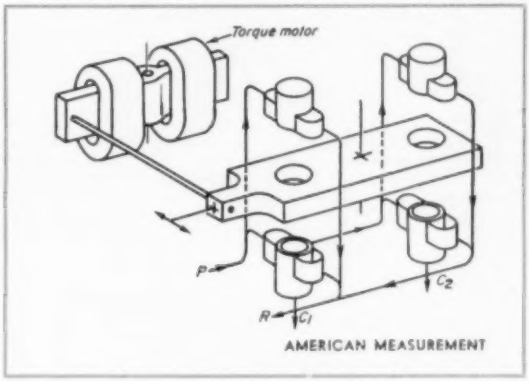
Oilgear, Model SC-VP10-001—Torque motor actuates swing plate mounted on spring steel supports. Eliminates metal-to-metal contact and gives high sensitivity, fast response to small signals. Torque motor armature twists torsion shaft, valve fails safe if power fails. For pressures to 3000 psi, compensating cap is added to equalize internal pressures, maintain clearances. Mounts in any position.



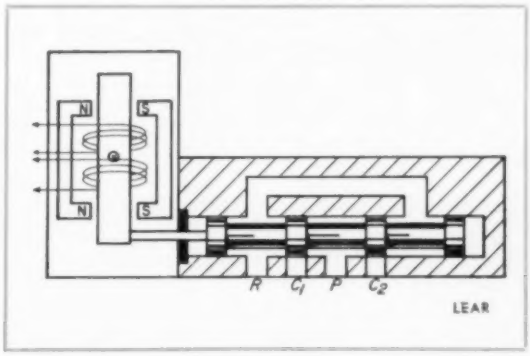
Minneapolis-Honeywell Regulator, Model VJ302—Hardened steel spool is mechanically connected to permanent magnet torque motor; valve body is aluminum; sleeve is hardened steel. Some models have differential transformer integral with valve body with core attached to spool. Feedback from transformer through amplifier improves frequency response, allows valve gain adjustment, and reduces spool stiction.



Midwestern Instruments, Model 4—Double-ended permanent magnet torque motor drives two balanced spools in push-pull motion. Result is same as single, 4-way spool. Spool shaping reduces flow forces. Both body and spools are hardened, alloy steel. Two-spool balanced design gives good performance during lateral vibration.



American Measurement & Control, Model 200—Single rotary plate design eliminates field adjustments and improves reliability. Stroking arm is factory-set. Torque motor exerts 15 lb at mid-position, controls only .6 gpm.



Lear, Model 5214—Permanent magnet torque motor drives 4-way spool through direct linkage. Valve gives constant flow regardless of load pressure. As load pressure rises, pressure drop across valve decreases, reducing Bernoulli force at valve spool. This allows force motor to move to higher setting and shift spool.

DESIGN 2 — 2-STAGE, SPOOL/SPOOL

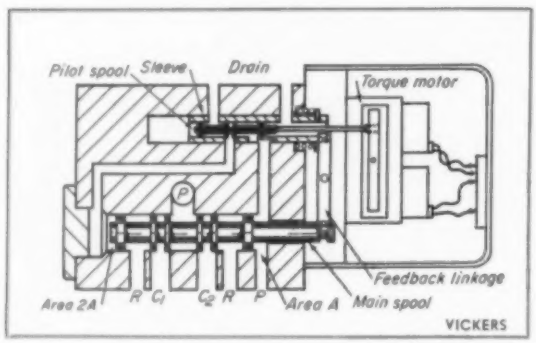
For higher flow rates the valve must supply more power. An additional stage of hydraulic amplification is used between the torque motor and output spool. One type has a small, pilot-spool first stage driving the output spool, either directly or through some decoupling mechanism.

All proportional 2-stage valves must use either spring-restraint on the second stage spool, or feedback. Since output pressure from the first stage moves the second stage spool, without springs or feedback, output flow would be proportional to the integral of the input signal.

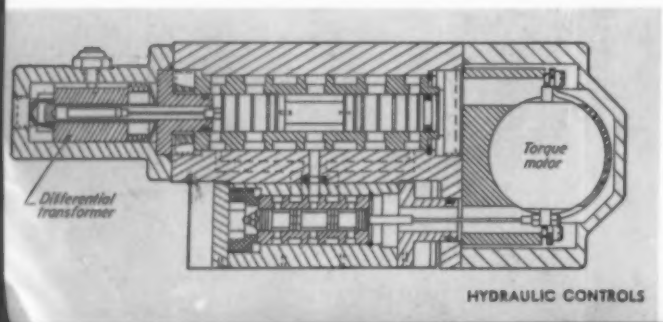
Two-stage, spool/spool valves control large loads. Flow rates up to 600 gpm are available. Like the single-stage valve, the first-stage, pilot spool can become jammed by small particles in the oil. Manufacturers have come up with various designs to prevent this, and most present valves work well with normally clean oil.

Manufacturer	Model	Max. Flow Rating[1] (gpm)	Frequency at 3 db down or 90° Phase Shift[2] (cps)	System Pressure (psi)	Torque Motor Power (mw)	Torque Motor Type	Max. Internal Leakage (gpm)	Weight (lb)
AMERICAN MEASUREMENT & CONTROL	230	10		5000				
BENDIX AVIATION, BENDIX RESEARCH LABORATORIES	241	26	340[3]	500-3000	1000	Dry		
BERTEA PRODUCTS		25	900[4]	3000-5000	10000	Stale[5]		
CONSOLIDATED CONTROLS	141SV69	12	120	300-4500	2[6]	Dry	0.1	1.25
HAGAN CHEMICALS & CONTROLS	80	46	8	500-2000	2500	Stale[5]	1.6	
	600	346	2	500-2000	1250	Stale[5]	12	
HYDRAULIC CONTROLS	D52	20	100	500-3000	3000		0.15	
SANDERS ASSOCIATES	SV-522	150	20	300-3000	2700	Stale	0.25	55
VICKERS	E-11089-4	18	60	300-3000	4000-12000			15

[1] 1/3 rated supply pressure across valve. [2] Average value under no-load conditions. [3] For 90° phase shift point only. [4] +3 db.
[5] Uses voice coil drive. [6] Manufacturer's claim of minimum power requirement.



Vickers, Series E-11089-4—Torque motor armature links to pilot stage spool by stiff wire. Control pressure applied at area **A** opposes pilot pressure applied at area **2A**. Feedback is through link connecting main spool and pilot-spool sleeve. When sleeve is positioned by movement of output spool, to new pilot-spool position, area **2A** is disconnected from pilot pressure. Link fulcrum is adjustable for best performance. Designed for industrial applications.



Hydraulic Controls, DS2—Output spool is either 3-or 4-way. Signal from linear differential transformer feeds into servo amplifier to close loop around valve. Recommended dither, 400 cps. Output spool moves .060 in. either side of null.

DESIGN 3 — 2-STAGE, FLAPPER-NOZZLE, SPRING-RESTRAINED SPOOL

The first stage has a fixed, upstream orifice and nozzle-flapper downstream orifice. Pressure in the chamber between the orifices drives the output spool. In a single nozzle (unbalanced) valve, first-stage pressure is ported to one end of the output spool, the other end is spring-restrained. Double nozzle (balanced) valves have two sets of opposing orifices and nozzles. Differential first-stage pressure drives the spool against restraining springs at either end.

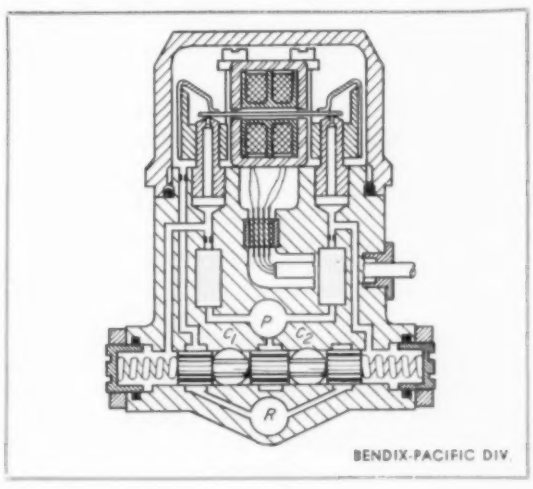
Single particles greater than 25 microns can contaminate the first stage of valves with an upstream orifice diameter of less than .010 inch, and nozzle flapper spacing of .001 in. The valves usually have micronic filtration to prevent contamination.

Power output of the nozzle-flapper first stage is less than a spool type pilot, but these valves have outputs to 20 gpm with a 1000-psi drop. They can be made very small and light. And with their excellent control characteristics, they are suitable for aircraft and missile applications.

Manufacturer	Model	Max. Flow Rating[1] (gpm)	Frequency at 3 db down or 90° Phase Shift[2] (cps)	System Pressure (psi)	Torque Motor Power (mw)	Torque Motor Type	Max. Internal Leakage (gpm)	Weight (lb)
BENDIX AVIATION CORP., BENDIX-PACIFIC DIV.	HR-A	4.5	120	500-4000	100		0.21	0.96
	HR-B	9.0	65	500-4000	100		0.33	1.25
DALMO VICTOR	10	6.0	230	500-3000	50	Wet	0.15	0.76
HYDRAULIC RESEARCH & MFG.	20	5.0	200[3]	150-4500	80	Dry	0.15	1.0
	21	10	140[3]	150-4500	80	Dry	0.25	1.1
	22	20	70	150-4500	80	Dry	0.35	
MOOG VALVE	21 Series	5.0	220	500-4500	50	Dry	0.16	0.75
	22 Series	10	125	500-4500	50	Dry	0.24	1.0
VICKERS, AERO HYDRAULICS DIV.		5.0	140[3]	500-3000	100	Dry	0.2	0.53
		12	60	500-3000	100	Dry		

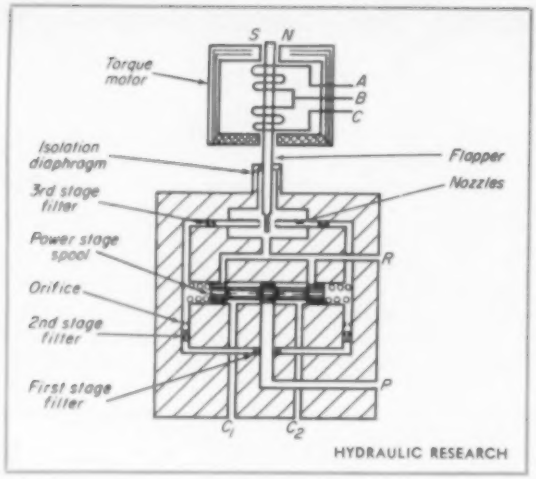
[1] 1/3 rated supply pressure across valve. [2] Average value under no-load conditions. [3] For 90° phase shift point only.

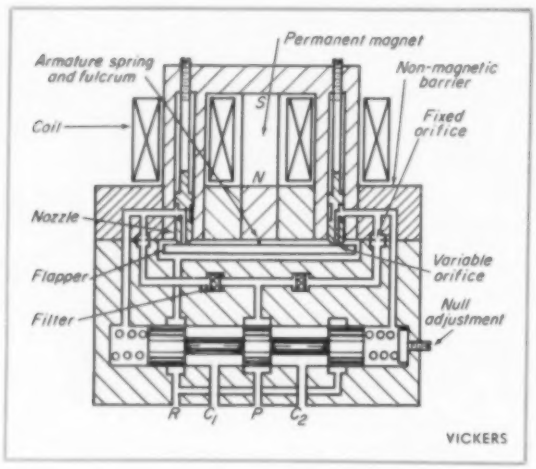
Dalmo Victor, Model 10—Wet, torque motor drive. Valve sleeve fabricated from five segments held in a retaining sleeve for alignment. Rectangular flow ports are produced by grinding radially across the segment face. This gives more precise port location and sharper flow edges. (No diagram shown.)

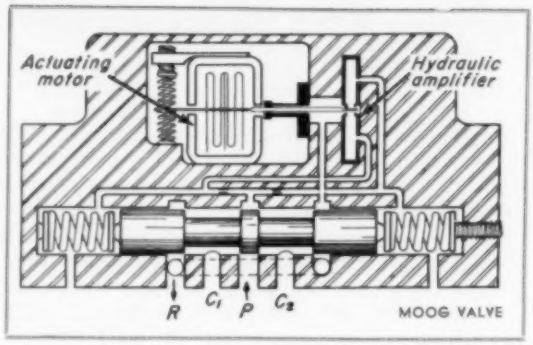


BENDIX-PACIFIC DIV.

Bendix-Pacific Div., Series HR—Valve has parallel rather than opposed nozzles. This allows use of torque motor with two air gaps and roughly doubles available torque. Flapper does not operate about a fixed pivot point, and first stage can pass large contamination particles. Mounting flapper spring on nozzles minimizes temperature effects on null shift.







Moog Valve, Series 21 and 22—Dry torque motor, low flow valve. Torque motor is isolated by actuating flapper through tubular flexure pivot which also acts as spring on flapper. Spring force of tubular flexure pivot is balanced by negative force gradient of permanent magnet motor. Spool position corresponds to electrical input signal, and gain is independent of supply pressure variations.

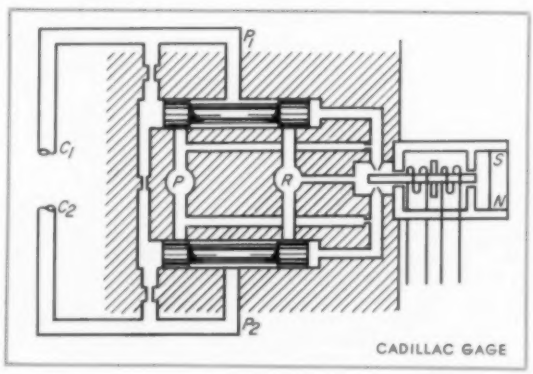
Hydraulic Research & Mfg., Model 20—Sleeve, spool and all parts of second stage, are stainless steel. Dry torque motor is completely encapsulated. Valve has three filters to improve reliability. First filter is at supply port; second, in front of upstream orifices; third, at the input to nozzles.

Vickers, Spacemaster—Lightest servo valve of the group. Unique feature is that the nozzles both point down with flapper suspended below them from a spring fulcrum. No mechanical motion is transmitted through barrier isolating sealed torque motor. Nozzles are mounted in pole pieces. High velocity nozzle flows keep variable orifices clean.

DESIGN 4 — 2-STAGE, FLAPPER-NOZZLE/SPOOL WITH FEEDBACK

The first stage has single or double flapper-nozzle design. Second stage has spool and sleeve design, but does not have restraining springs. Output flow, pressure, or a combination is fed back to flapper or spool. Several of these valves have force or position feedback from spool to flapper. They can be made with very high stage pressure gain. For small input signals, this increases spool-end forces compared to equivalent valves without feedback.

Because of various feedback methods, valves in this class can be built for a wide range of characteristics. Except for a few industrial models, size and weight are relatively small, and these are used extensively for aircraft and missiles.

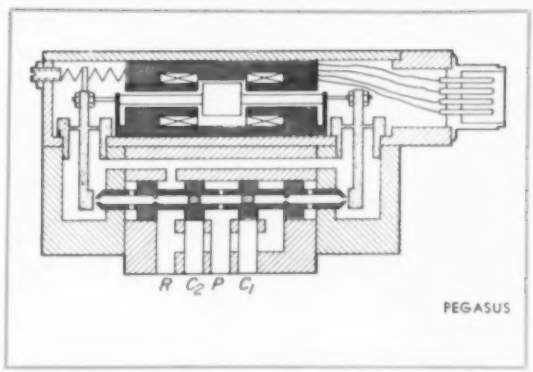


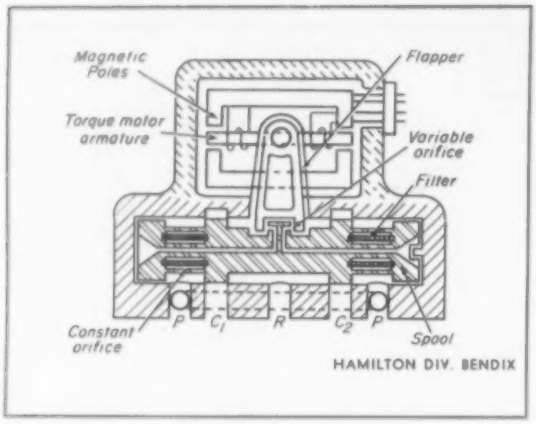
Manufacturer	Model	Max. Flow Rating[1] (gpm)	Frequency at 3 db down or 90° Phase Shift[2] (cps)	System Pressure (psi)	Torque Motor Power (mw)	Torque Motor Type	Max. Internal Leakage (gpm)	Weight (lb)
BENDIX AVIATION, HAMILTON DIV.	A27A	7.0	500[4]250[3]	100-3000	800	Dry		2.25
	A45A	12.0	150[3]	100-3000	800	Dry		3.80
	A8A	2.0	250[3]	100-3000	800	Dry		2.00
BORG WARNER, PESCO PRODUCTS DIV.	413637	7[3]	150	500-3000	64	Dry	0.1	0.7
CADILLAC GAGE	PC 2[9]	10	150[6][3]	500-4000	65	Wet	0.25	1.3
	PC 3	10	150[6][3]	500-4000	65	Stale	0.25	0.9
	PC 10	10	150[6][3]	500-4000	66	Dry	0.25	1.3
	PC 24	20	100[6][3]	500-4000	65	Stale		
	FC 10[9]	13	120	500-4000	65	Stale	0.40	1.1
	FC 11	4	120	500-4000	65	Stale	0.20	1.1
	FC 30	3	120	500-4000	65	Stale	0.15	0.9
	FC 31	13	120	500-4000	65	Stale	0.40	0.9
	FC 300	2.5	120[4]	100-3000	50	Dry	0.10	1.2
	FC 400	4.5	70[4]	100-3000	50	Dry	0.18	1.5
HYDRAULIC RESEARCH & MFG.	26	15	180[2]	100-4500	80	Dry	0.3	1.0
MOOG VALVE	Series 15	10	220[8][2]	500-4500	50	Dry	0.25	1.0
	Series 16	10	120[7]	500-4500	50	Dry	0.25	1.2
	Series 31	5	200[3]	50-4000	80	Dry	0.15	0.8
	Series 32	10	120[3]	50-4000	80	Dry	0.24	0.8
PEGASUS LABORATORIES	120F	5.0	100	200-3000	1500	Dry	0.2	2.75
	140C	10	80	200-3000	1500	Dry	0.3	3.6
	10A-0.5	0.5	140	1000-3000	80	Dry	0.05	0.74
	10A-2	2.0	140	1000-3000	80	Dry	0.1	0.74
	20A-5	2.5	110	1000-3000	80	Dry	0.15	1.24
	20A-8	8.0	110	1000-3000	80	Dry	0.15	1.24
	180A	20	40[3]	1000-3000	3750	Dry	0.4	16
	1160B	40	40[3]	1000-3000	3750	Dry	0.6	16
	1640B	160	30[3]	200-3000	3750	Dry	2.1	45
SANDERS ASSOCIATES	SV-219	8.5	90	500-5000	1200	Stale	0.45	3.7
	SV-324	45	80	500-3000	1200	Stale	0.53	7.5
STANDARD CONTROLS	PC-6[5]	8[3]	230[6][3]	4000	125	Dry	0.1	
WESTON HYDRAULICS	—	8.0	100	500-3000	64	Dry	0.22	0.83

[1] 1/3 rated supply pressure across valve. [2] Average value under no-load conditions. [3] For 90° phase shift point only. [4] When first-stage flow equals 0.5 in ^{2}/sec. [5] Pressure drop across valve not specified. [6] Blocked Load Response. [7] Flow response to both current and load pressure. [8] Specification for PC-6 applicable to PC-5 and PC-5L if allowances are made for difference between 3-way and 4-way valves. [9] PC indicates pressure control; FC indicates flow control.

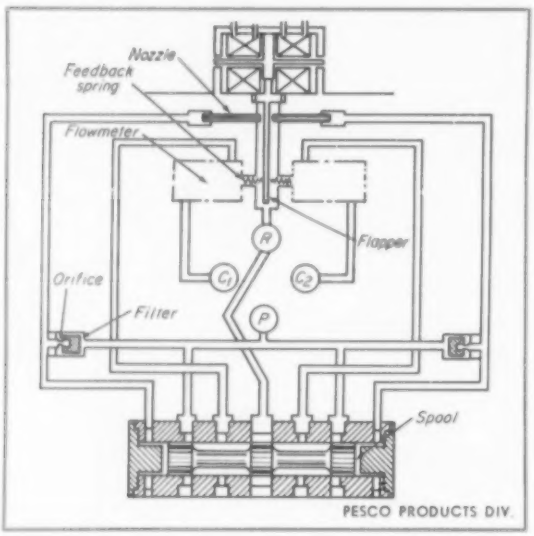
Cadillac Gage, PC2—Opposed nozzle-flapper first stage. Each nozzle is hydraulically connected to a separate spool. Opposite ends of spools are hydraulically connected together and to load through orifice arrangement so proportional load pressure is fed back to spools. Output pressure differential is then proportional to input electrical signal.

Pegasus, Model 120F—Nozzles are an integral part of spool. When differential signal is applied to valve, one of two opposing pivot rods is forced closer to spool, and other is forced away. Increased pressure at one spool end moves spool away from pivot rod until forces on spool ends are balanced.

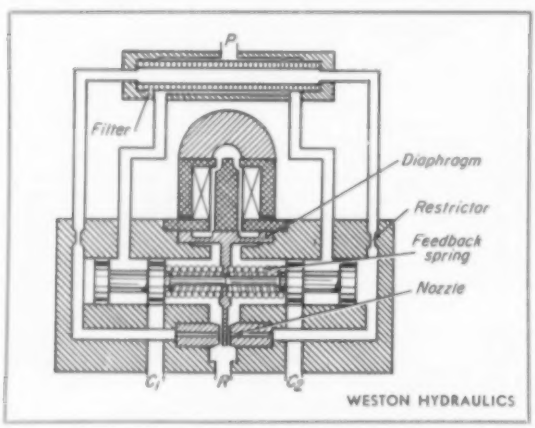




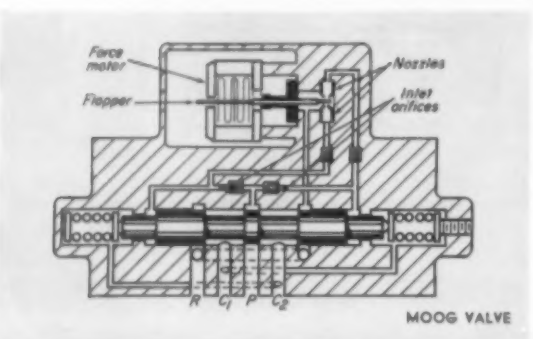
HAMILTON DIV. BENDIX



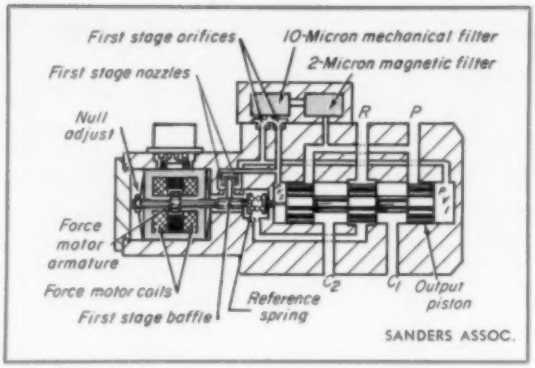
PESCO PRODUCTS DIV.



WESTON HYDRAULICS



MOOG VALVE



SANDERS ASSOC.

Sanders Associates, Model SV-324—First stage, which receives oil from main supply through a micronic and magnetic filter, is a dual, balanced flapper displaced between two fixed orifices. Force motor is linked to first stage flapper through a reference spring to give force feedback.

Differential pressure from first stage orifices is fed to opposing ends of second stage (output) spool, displacing it. Spool moves until feedback force equals force motor force. First stage flapper is re-balanced, differential pressure between first stage orifices is zero, and output spool is then positioned to port oil to load.

Bendix Aviation, Hamilton Div., Models A27A, A45A, A8A—Dry torque motor, closed loop valves. Spool position corresponds to electrical input signal and is essentially independent of supply pressure or temperature variations. Pilot-stage nozzles are mounted on spool, facing away from each other, and are straddled by a fork-shaped flapper. Movement of flapper by torque motor-enlarges one gap and reduces other. This creates a pressure differential on spool ends. Spool moves until nozzles are centered and flow is equalized.

Pesco Products Div., Model 413637—Uses flow feedback. Output flow is monitored through flowmeter linked to flapper. Movement from null causes differential, spool-end pressure which shifts spool. Output flow differential sensed by flowmeters returns flapper to center.

Weston Hydraulics—Valve uses force feedback from spool to flapper. Locating nozzles in bottom of valve permits high amplifier gain at reasonable nozzle clearances, and best acceleration damping characteristics of pressure feedback. Nozzles and sleeve are close to valve centerline to minimize null shift from temperature variations. Ten-micron filter can be replaced without removing valve.

Moog Valve, Series 16—Uses both load pressure feedback and spool restraining springs. Slope of static pressure-flow characteristics can be established by internal valve parameters. Alternate designs include a high-pass hydraulic filter network to feed back only dynamic load pressure variations. System static stiffness is thereby retained.

Hydraulic Research & Mfg., Model 26—Flapper is extended to link directly with second-stage spool. Spool motion forces flapper away from nozzle it had previously restricted. Spool moves until force feedback from flapper equals torque motor force. Pressures on spool ends are balanced at new equilibrium position. One large filter is installed at valve input. This valve is designed to operate at oil and ambient temperatures from —65 F to +750 F. (No diagram shown.)

DESIGN 5 — 2-STAGE, SLIDER/SPOOL

Each side of the first stage has two orifices in series. Controlled differential pressure to the second stage is obtained from the chambers between them. The downstream orifices which are variable, consist of a slide which covers a small hole. Two opposing series of orifices provide differential pressure to drive the second stage spool.

Conventional spool and sleeve design is used for the second stage. Restraining springs or feedback can be used to control spool position.

Manufacturer	Model	Max. Flow Rating[1] (gpm)	Frequency at 3 db down[2] (cps)	System Pressure (psi)	Torque Motor Power (mw)	Torque Motor Type	Max. Internal Leakage (gpm)	Weight (lb)
G. P. E. CONTROLS	Series 6100	4.0	100	500-3000	350	Stale	0.21	

[1] 1/3 rated supply pressure across valve. [2] Average value under no-load conditions.

DESIGN 6 — 2-STAGE JET PIPE/SPOOL

A jet impinging on one, or proportionally on both, of two receptor orifices forms first stage. Orifices are each connected to one spool end chamber. Position of jet (and spool-end pressure) is controlled by the torque motor acting through a torque-tube coupling. Manufacturer's data states that the smallest first stage opening is the jet pipe itself with diameters of 0.009 to 0.03 in. Single particles of 200 microns should pass such an orifice.

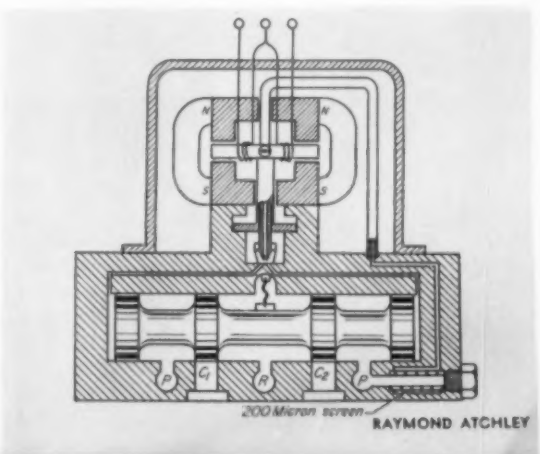
Second-stage spool and sleeve construction is conventional. Spool position may be controlled by restraining springs or feedback.

Flow ratings range to 50 gpm with a 3000-psi supply. At lower flow ratings, size and weight are about the same as valves with flapper-nozzle first stage, so the valves are suitable for aircraft and missiles. Valves for large flows are much heavier and are therefore mostly for industrial uses.

Manufacturer	Model	Max. Flow Rating[1] (gpm)	Frequency at 3 db dow n[2] (cps)	System Pressure (psi)	Torque Motor Power (mw)	Torque Motor Type	Max. Internal Leakage (gpm)	Weight (lb)
RAYMOND ATCHLEY	410	5	90	300-4500	80	Dry	0.1	0.70
	415	10	80	300-4500	80	Dry	0.1	0.81
	425	20	50	300-4500	80	Dry	0.25	2.75
	450	50	40	300-4500	1000	Dry	0.3	19

[1] 1/3 rated supply pressure across valve. [2] Average value under no-load conditions.

Raymond Atchley, Model 410—Flexible, jet pipe first stage is linked to second stage spool with feedback spring. In null position, jet pipe is equidistant from two receptor orifices connected to spool ends, giving balanced forces on spool. When signal is applied to torque motor, jet pipe flexes causing difference of pressure and forces on spool. Spool movement is fed back to jet pipe through spring which applies force opposing that of torque motor. Valve is balanced at new position when jet pipe is returned to its null position and differential pressure is zero. Output flow is then proportioned to input differential current.



DESIGN 7 — TIME-MODULATED TORQUE MOTOR

In these valves, magnitude of the electrical input signal is not proportional to system error. The input signal is an asymmetrical constant amplitude square wave. The time difference of positive to negative pluse length is the controlling factor. A multivibrator must be used to produce this square wave. Design of these valves can probably be similar to any using proportional amplitude input signal. However, the pulse characteristic of the input signal should be applied to the spool so the valve's load in combination with its output stage can give the necessary smoothing action. With 2-stage valves such as those with nozzle-flapper first stage, this requires a larger torque motor to insure that the flapper will always be hard over against one nozzle or the other except for transit time.

The first time-modulated valve on the market did not have spool restraining springs or output feedback. As a result any unbalance in the input signal pulse time moved the spool at a rate proportional to this time difference. External position feedback, with an appropriate lead network, or alternately velocity feedback, was required to stabilize this time-modulated valve system. However, this requirement is not necessarily related to the time-modulated nature of the input signal.

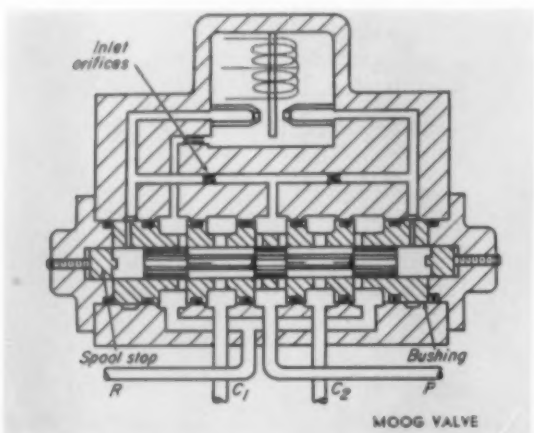
Valves which operate with a time-modulated input signal require the added complexity of a multivibrator circuit in the control system. Although there is very little operating experience with this type of valve at present, they will probably work better in contaminated oil than most present valves and will have a relatively small null shift in a large temperature range. Other advantages claimed by manufacturers of time-modulated valves are: elimination of hysteresis and threshold; less critical mechanical tolerances; less critical electric transducer linearity requirements; silting eliminated; and drift eliminated.

Manufacturer	Model	Max. Flow Rating[1] (gpm)	Frequency at 3 db down or 90° Phase Shift[2] (cps)	System Pressure (psi)	Torque Motor Power (mw)	Torque Motor Type	Max. Internal Leakage (gpm)	Weight (lb)
BENDIX AVIATION, BENDIX-PACIFIC DIV.	AS-Series A	4.5		400-3000	100	Wet or Stale	0.21	1.0
	AS-Series B	9.0		400-3000	100	Wet or Stale	0.33	1.25
EASTERN INDUSTRIES	E/SV 105-200R	4.0[3]	150[4]	3000	4000[5]	Wet	0.14	1.3
GARRETT CORP, AIRESEARCH MFG.	TSV100	6.0		500-3000	100	Wet	0.108	1.25
	TSV300	15		500-3000	100	Wet	0.108	1.5
MOOG VALVE	Series 19	6.0		500-4000	35	Wet or Dry	0.195	1.0

[1] 1/3 rated supply pressure across valve. [2] Average value under no-load conditions. [3] Pressure drop across the valve is not specified.
[4] For 90° phase shift point only. [5] Uses preamplifier to drive solenoids.

Moog Valve, Series 19—One of limited number of valves available for time-modulated control. This valve is called an **acceleration switching servo valve** because acceleration of the power actuator is proportional to continuous switching input.

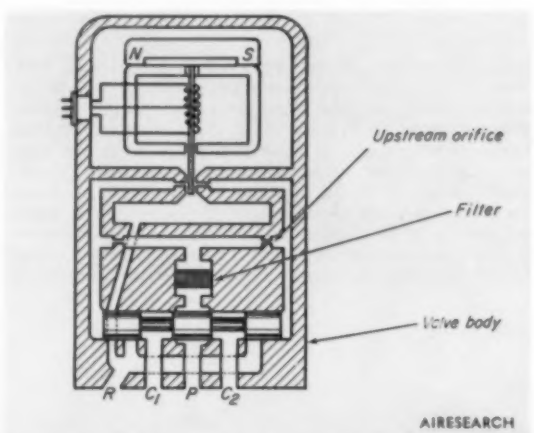
Two-stage valve has nozzle-flapper first stage and spool-in-sleeve second stage without restraining springs.



MOOG VALVE

AiResearch, Mdel 300—Uses time-modulated control with nozzle-flapper first stage and output spool without restraining spring or feedback.

Absence of restraining spring or feedback does not result in a perfect integrator because of flow forces on spool. These act like spool restraining springs, prevent output spool from integrating at low frequencies.



AIRESEARCH

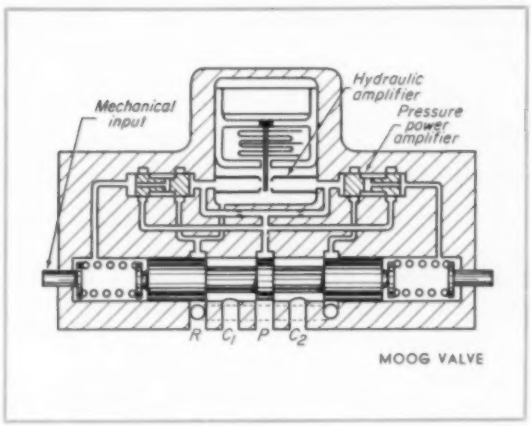
DESIGN 8 DUAL INPUT

These valves have both an electrical and mechanical input and act as a summing point for both. They were developed primarily for aircraft flight control systems where simultaneous commands from the pilot and the flight-stability augmentation system must be applied to the control surfaces.

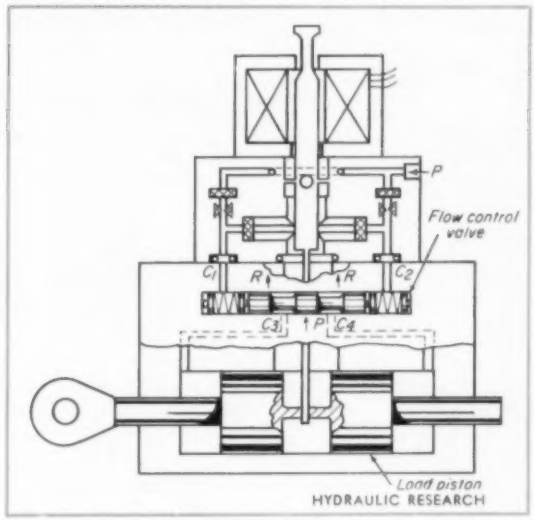
Present valves have nozzle-flapper first stage and spring-restrained spool second stage. Mechanical input is applied directly to the output spool or to the torque motor armature through a linkage. Override and lockout features permit a mechanical override and disconnect of the electrical input. Possible application is in damping systems to improve airframe stability.

Manufac—turer	Model	Max. Flow Rating[1] (gpm)	Frequency at 3 db down[2] (cps)	System Pressure (psi)	Torque Motor Power (mw)	Torque Motor Type	Max. Internal Leakage (gpm)	Weight (lb)
HYDRAULIC RESEARCH & MFG.	Hydemat	10	50-100	700-3000	80	Dry		4.5
MOOG VALVE	Series 10	12	100	1000-3000	50	Dry		

[1] 1/3 rated supply pressure across valve. [2] Average value under no-load conditions.



Moog Valve, Series 10—Valve operates as a mechanical input valve, dual input valve, and electrohydraulic servo valve. All valves in series have (1) 4-way slide valve either dual or single, (2) mechanical input linkage, (3) an electrohydraulic first stage. Optional components are: (1) solenoid-operated on-off slide valve for pressurizing first-stage drive, (2) travel-limiting and mechanical lockout pistons, (3) solenoid-operated, on-off slide valve for actuating lockout, (4) mechanical, hydraulic over-ride of lockout system, (5) piston-port interconnecting emergency by-pass valves.



Hydraulic Research & Mfg.—Valve operates as a mechanical input valve, dual input valve, and electrohydraulic servo valve. Distinguishing feature is that mechanical and electrical inputs are summed at flapper rather than output spool during dual-mode operation. Force feedback is from spool, rather than restraining springs.

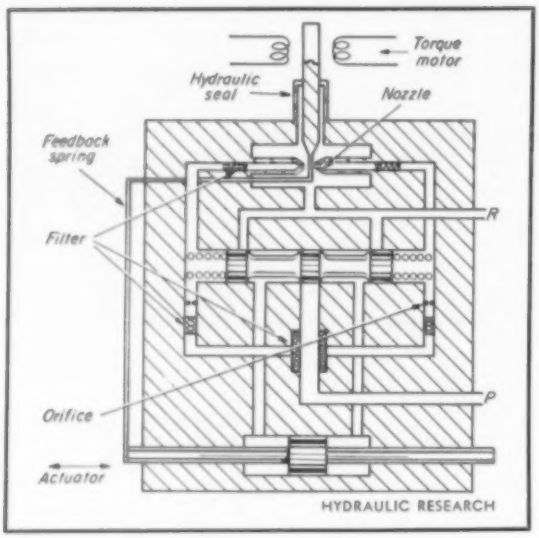
DESIGN 9 VALVE—ACTUATOR COMBINATION

The valve itself has a flapper-nozzle first stage and spring-restrained spool second stage. A linear actuator, controlled by the valve is packaged with it. Mechanical position feedback is from actuator to the valve flapper eliminating an external feedback element.

Another type of integrated system is one in which actuator velocity is hydro-mechanically measured and fed back to the flapper to produce error-rate damping.

Manufacturer	Model	Max. Flow Rating[1] (gpm)	Typical Frequency at 3 db down or 90° Phase Shift[2] (cps)	System Pressure (psi)	Torque Motor Power (mw)	Torque Motor Type	Max. Internal Leakage (gpm)	Weight (lb)
HYDRAULIC RESEARCH & MFG.	Electro Hydraulic Integrated Actuator	10	25[3]	500-4500	80	Dry		

[1] 1/3 rated supply pressure across valve. [2] Average value under no-load conditions. [3] For 90° phase shift point only.



HYDRAULIC RESEARCH

Hydraulic Research & Mfg., Electrohydraulic Integrated Actuator—Combines actuator and valve in single unit with output position proportional to input current. Mechanically feeds back actuator position to flapper. First stage is typical, dual nozzle-flapper design. Second stage is spring-centered spool. Spring feedback from actuator to the flapper opposes magnetic force so actuator position of closed loop device is proportional to input signal. For most applications, no additional position feedback is needed. In this situation, valve driver amplifier would be operating open loop. For many applications, this would require highly linear amplifier response with low drift. However this problem is minimized because amplifier gain and power requirements are normally very low.

DESIGN 10 — 3-STAGE, HIGH FLOW

Three-stage valves have the advantages of a flapper-nozzle first stage with increased output flow. They are a 2-stage, pressure control valve driving a large spring-restrained output spool. Output flows go as high as several hundred gallons per minute.

Moog Valve, Models 11, 12—High flow control valves combine pressure control valve with extra stage of hydraulic amplification from large, spring-restrained spool, output stage.

Cadillac Gage, Model FC 40—Single nozzle first stage is hydraulically connected to one end of second-stage spool. Other end has reduced area subjected to full supply pressure for balance. Large area end is connected to flapper through beam-and-spring feedback. Third stage of hydraulic amplification permits valve to handle high flows.

Raymond Atchley, Model 475—First two stages are either Model 415 or Model 425 valve which operate like Model 410 (see above) but are bigger. Output stage is conventional spool-and-sleeve construction. Position feedback provided by differential transformer.

Manufacturer	Model	Max. Flow Rating[1] (gpm)	Frequency at 3 db down or 90° Phase Shift[2] (cps)	System Pressure (psi)	Torque Motor Power (mw)	Torque Motor Type	Max. Internal Leakage (gpm)	Weight (lb)
RAYMOND ATCHLEY	475	250	35	300-4500	80	Dry	0.8	300
CADILLAC GAGE	FC-40	40	90	500-4000	100	Stale		
MOOG VALVE	Series 11	35	70	1000-3000	50	Dry		
	Series 12	100	60[3]	1000-3000	50	Dry		

[1] 1/3 rated supply pressure across valve. [2] Average value under no-load conditions. [3] For 90° phase shift point only.

TABLE I. CHARACTERISTICS OF SYSTEM CONTAMINATION

Particle Properties	Effect on Valve	Correction
Size	Orifices and nozzles are plugged by particles their same size or larger. Valve spools stick because of trapped particles. Hysteresis increases.	Adjust filters to particle size. Since system null leakage and dead band requirements establish diametral clearance, correction depends on valve design.
Shape	Filters are effective on particle's smallest dimension only. Orifices, nozzles and passages trap particles because of largest dimension.	Eliminate fibrous contaminants which can pass filters and build up in the valve.
Material	Magnetized particles can form clusters. Sticking, change in leakage and deadband characteristics is caused by hard abrasive particles. Flexible materials work through filters, change shape and build up.	Properly design the valve and eliminate contaminants.
Suspension (light particles will suspend in fluid more than heavy particles; small ones more than large of the same density)	Malfunction caused by suspended particles being carried into the valve.	Analyze tubing configuration, fluid viscosity, environmental conditions such as vibration and temperature which affect particle suspension.

Instability, slow response, and complete failure of an electrohydraulic servo valve can result from fluid contamination. How is servo design related to contamination? What must the valve user know about contamination to improve system reliability?

How contamination affects servo valve design

• By RICHARD E. OSGOOD, *Research Engineer, Boeing Airplane Company, Seattle, Wash.*

This article was awarded fifth prize in the 1958 APPLIED HYDRAULICS & PNEUMATICS Prize Paper Contest.

CONTAMINATION control offers improvement in reliability of servo systems. However, because of cost and complications in the field, it is not the final solution. Improved servo valve design is needed.

• **Defining Contamination**—Table 1 charts the characteristics of contaminants found in hydraulic servo systems. Amount of contamination in a hydraulic fluid is defined by:

1. Distribution—percent of contamination of one particular size, shape, or material compared to all contaminants in the system.
2. Concentration—amount of contamination compared to amount of fluid; usually expressed by particle count or weight per unit volume of hydraulic fluid.

• **Orifice and Nozzle Design**—As a general rule the orifices and nozzles of a valve should be designed as large as practical to avoid contamination problems and still not require excessive fluid flows. The problem of filtration is easier for large particles than for small.

Protect all the orifices and nozzles in a servo valve from contamination. It is normal manufacturing

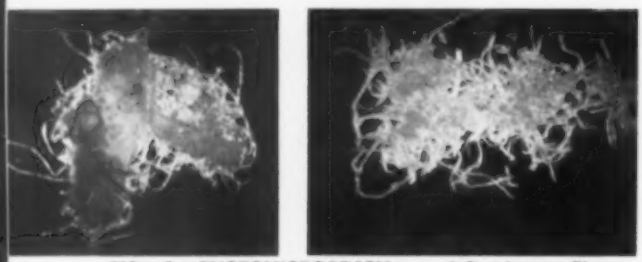


FIG. 1. **PHOTOMICROGRAPH** on left shows fibrous particles that made missile valves fail. Hydraulic fluid covering part of the fibers looks solid. On right are fibers pulled loose from surface of paper element filter. The fibers that caused the failure may have come from a fiber shedding filter.

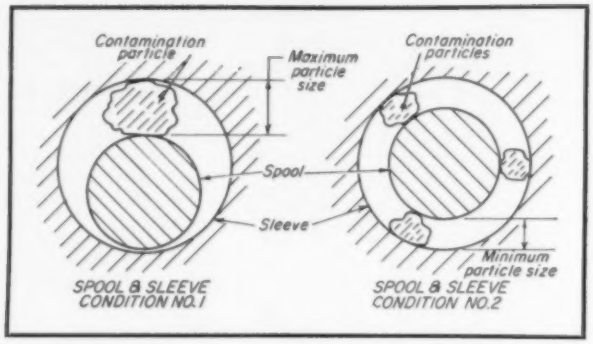


FIG. 2. **RELATION** of spool and sleeve diametral clearance to contamination particle size.

TABLE 2. CONTAMINATION SIZE RANGE WHICH CAUSES INCREASED FRICTION BETWEEN A SPOOL AND SLEEVE OF A GIVEN DIAMETRAL CLEARANCE.

SPOOL AND SLEEVE DIAMETRAL CLEARANCE (millionths of an inch)	CONTAMINATION SIZE RANGE (microns)
40	.5—1
80	1.0—2
120	1.5—3
160	2.0—4
200	2.5—5
240	3.0—6
280	3.5—7
320	4.0—8
360	4.5—9
400	5.0—10
440	5.5—11
480	6.0—12
520	6.5—13
560	7.0—14

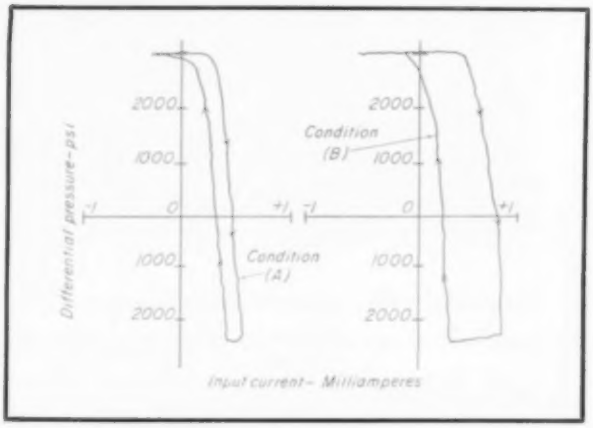


FIG. 3. **TWO DEADBAND** hysteresis curves of a servo valve operating in (A) relatively clean fluid and (B) in fluid with 1.0 milligram per 100 milliliter contamination.

practice to attach a protecting filter to the individual orifice or nozzle even before the servo valve is assembled. It prevents clogging from dust or machined particles present in the assembly area.

The internal valve filters should be designed to protect the orifices and nozzles, but not so fine that particles build up and block the flow. Filter surface area should be as large as possible. However, since space limitations mean small size filters, the internal valve filters should be matched to the system filters. The orifice protecting filters in the valve should be designed to pass larger size particles than are passed by the main system filters. This will greatly reduce danger of plugging small area filters inside the valve.

Orifice or nozzle protecting filters made of sintered bronze balls or similar material should also have a screen to prevent plugging by a free piece of sintered material which might be broken loose. Paper or cloth filters are dangerous because the fibers might get in the fluid. The danger grows as the flow increases.

To prevent contamination sensitivity in the first stage of the electro-hydraulic servo valve all components in a hydraulic system must be free of contamination when assembled. Proper filtration must be provided to maintain a clean system.

• **Spool and Sleeve Design**—The spool and sleeve section of the valve generally cannot be protected by an internal filter. It is exposed to contamination in the main system. Filters should be located to protect the servo valve from particle generating components wherever practical. Pumps, motors, actuators and accumulators are a few of the more common contamination sources. When the valve is mounted directly on an acutator or motor, no protection is possible from contamination on the port open to return. The spool and sleeve of the valve must therefore be designed to operate in the type of contaminant generated by the loading device and whatever particles are passed by the system filters. Contamination sensitivity of the spool and sleeve of a servo valve is related to a single contaminant size as shown in Figure 2.

When particles fit the diametral clearance of the servo valve spool and sleeve, Table 2, increased friction will develop if there is sufficient concentration of the contaminant. A contaminated fluid may contain a particle size spread sufficient to invalidate the single size contamination analysis. In this case a spool and sleeve of a given diametral clearance will be sensitive

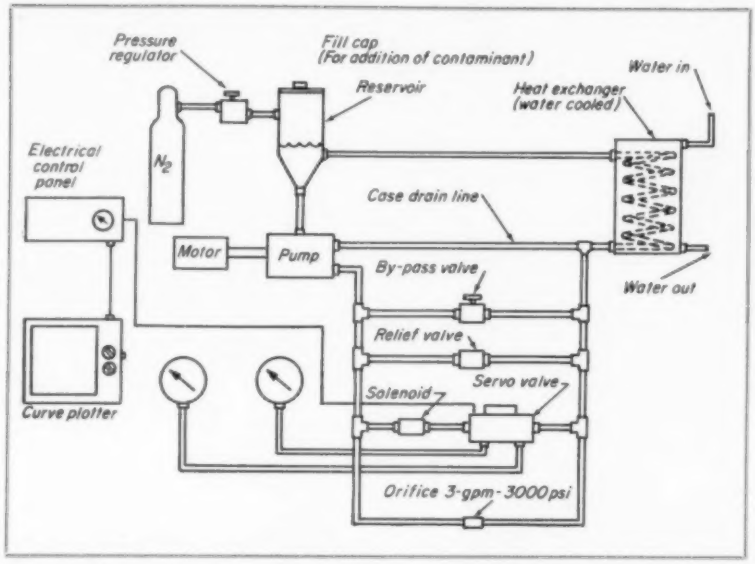
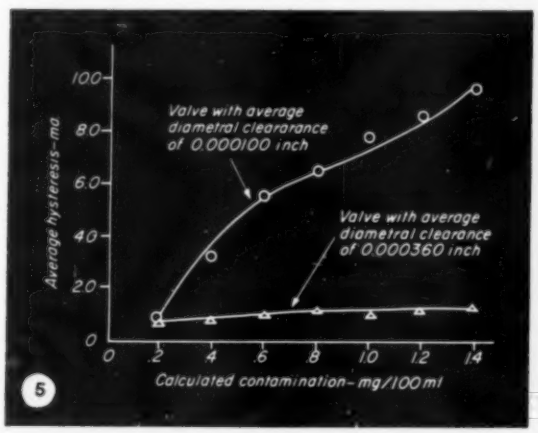
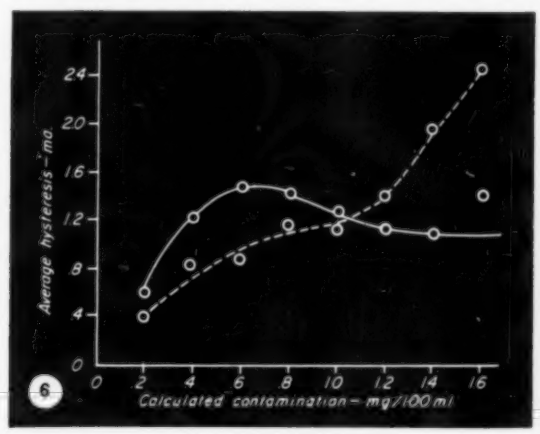


FIG. 4. TEST SET-UP. Contaminant from a missile system was duplicated. It contains 50% by volume of type SF Carbonyl iron power, simulating metallic contaminant, and 50% by volume of AC fine dust, simulating nonmetallic contaminant. 95% of the particles are in 0-5 micron range; remainder are in 5-40 micron range. Valve operation was observed by means of hysteresis curves taken in the null region as the contamination concentration was increased.


Valve with average diametral clearance of 0.000100 inch
Valve with average diametral clearance of 0.000360 inch
Average hysteresis - ma
Calculated contamination - mg/100 ml
5



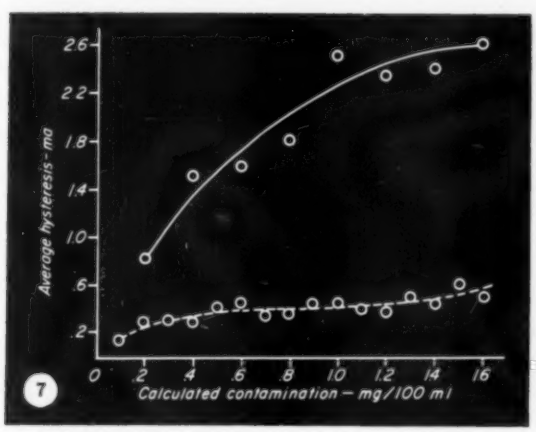


FIG. 5. CONTAMINATION sensitivity test of two pressure control valves identical except for spool and sleeve diametral clearances.

FIG. 6. SOLID LINE shows contamination sensitivity test of a flow control valve with spool and sleeve diametral clearance of 100 millionths of an inch and with an internal force feedback system. Dashed line shows test of same valve with no internal force feedback system.

FIG. 7. SOLID LINE shows same test as in Fig. 6 but valve used here has twice the area of contact between the spool and sleeve. Dashed line shows test of a flow control valve with extra high slide positioning forces per unit input current.

to particles smaller than the minimum but never larger than the maximum size shown in Table 2.

Valve hysteresis. Figure 3, varies with the contamination level. If the force available to position the valve spool is less than the friction forces then the valve will not work at all.

To study the effects of spool and sleeve contamination sensitivity and to determine design criteria for optimum servo valve reliability, a special test was devised, Figure 4.

Artificial contaminant was mixed with hydraulic fluid by ultrasonic vibrations and circulated in the system for about five minutes. To maintain constant conditions throughout the system, the fluid was circulated through an orifice at 3 gpm. The servo valve was operated in the system at each level of contamination just long enough to exercise the valve for about 10 seconds and run the hysteresis curve. All the valves tested were rated at 10 ma maximum input current.

• **Tests Results**—Curves in Figures 5 through 7 show the results. Too large a spool and sleeve diametral clearance can cause excessive null leakage and alter the dead band characteristics. Large clearance increases will not result in much leakage change if the spools and sleeves have considerable overlap as they did in the pressure control valve tested, Figure 5.

If the contamination size is predominantly in a higher range, then a small spool and sleeve clearance may be recommended. The limit of minimum clearance would be determined by the amount of pressure and/or temperature distortion anticipated in the spool and sleeve. It is general practice to have a larger clearance for valves designed for high pressures and/or wide temperature ranges than those designed for low pressures and/or narrow temperature ranges.

One of the most important factors in designing a valve for low contamination sensitivity is the amount of force available to position the spool per unit input signal. The spool and sleeve clearances will establish to what particle size range the valve will be most sensitive, but the degree of sensitivity is largely determined by the spool positioning forces. For this reason, servo valves with internal feedback loops (high positioning force levels on the spool per unit input current) are more desirable from the standpoint of contamination sensitivity than valves without, Figure 6.

Contact area between the spool and sleeve also has an effect on the contamination sensitivity, Figure 7.

Spool and sleeve diametral clearances can be adjusted below or above the predominant size range of contamination of a system. However, since it is impossible to predict the contamination size range in a particular system at any one time, the valves should be designed to operate with spool and sleeve clearance adjusted to the known predominant size range. Figure 7 shows the results of a contamination sensitivity test run on a valve whose spool and sleeve is sensitive to the artificial contaminant used in the test. The reason for low contamination sensitivity in this valve is the high positioning forces on the spool per unit input current.

A valve with low clearance and overlap, if operated at the null position, will act like a filter for extremely small particles. If the valve spool is not moved and the particles washed free from time to time, the contamination will build up and cause sticking of the spool in the sleeve. To prevent it, a valve with a tight spool and sleeve fit should have some underlap to permit the leakage to be close to the maximum allowed. Electrical dither input accomplishes the same thing. In valves with larger clearances between spool and sleeves, underlap or dither is not required.

WHAT SHOULD BE DONE

1. Develop ways to control contamination in not only the final servo system but also during assembly and test.
2. Design servo valves that will work in contaminated fluids. Some suggestions:
   a. Design larger orifices or nozzle openings in the valve first stage.
   b. Develop a new type of hydraulic amplifier that does not require orifices or nozzles but retains the operational advantages of the nozzle flapper system.
   c. Reduce the spool and sleeve contact area to a minimum for low friction forces even in a contaminated system.
   d. Develop new types of metering having little or no sliding contact for the servo valve second stage.

• **Special Contamination Problems**—Where unprotected torque motor servo valves (hydraulic fluid flowing through the torque motor armature gaps) have been used, contamination with a considerable percentage of magnetic particles has caused excessive hysteresis to develop. The particles get trapped by the magnetic field in the armature gaps, and in a short time dampen the inherent armature dither which had served to keep the spool and sleeve friction low. The system in which this condition occurred developed instability or sluggishness. If the magnetic particles are allowed to continue building up, eventually the valve completely loses control. To prevent this, valve manufacturers produce valves with torque motor armature gaps protected from the hydraulic system fluid flow.

Severe cycling with an electrical input signal without hydraulic power can cause plugging of the opening between the nozzle and flapper even though the protecting filter is adequate for the initial valve tolerances. The flapper hits the nozzles, roughens the edges around the nozzle orifice where small particles that would normally pass through are trapped. This clogging can be prevented by proper nozzle and flapper material, care in system operation, and by maintaining a maximum gap between nozzle and flapper.

Contamination has been found in a hydraulic system using rubber lined flex hose. The unusual hydraulic fluid dissolved some of the plasticizer in the rubber.

Some fluids form gummy substances when even small quantities are mixed with other types of fluid. A hydraulic system can become contaminated from test equipment or instruments used previously in a system running on a different, incompatible, hydraulic fluid. Some types of hydraulic fluid, especially the new synthetics, form deposits of varnish or gums. MIL-H-5606A hydraulic fluid, as received, must be considered contaminated and unsatisfactory for use with servo valves. □□□

Hydraulic "Controlled Flow-Pressure" Valve maintains desirable mower cutting speed

The 12,000 acres of grass on New Jersey's 173-mile Garden State Parkway are kept neatly manicured. Teams of Anderson hydraulic mowers like the one pictured above are the only sickle bar mowers used.

Key fluid power components in this first successful oil-hydraulic operated bar-type mower which has proven so efficient are the gear pump, tandem control valves and gear motor designed and produced for this specific application by COMMERCIAL. Power from the hydraulic pump is piped to the tandem directional control valves which functionalize the power to operate cylinders which position the sickle bar and a hydraulic motor to give it reciprocal cutting action.

A special "Flow and Pressure Control-Divider" Valve, built integral as one of the sections in the COMMERCIAL valve bank, automatically governs at all times the amount of power which reaches the motor and when necessary actually divides the total power output between the motor and cylinders.

CONTROLLED FLOW—automatically maintains a constant, governed flow of fluid power to the hydraulic motor. It holds the variation in motor revolution to a minimum even when the tractor engine is revved to full throttle. Fluid power thus generated in excess to demand is bypassed.

THE RESULT: Mower cutting speed is automatically controlled and maintained at maximum efficiency for all straightaway mowing conditions and the danger of damage to mower parts, plus operator fatigue, which vibration due to excessive speed could cause, is eliminated.

PRESSURE CONTROL—When the hydraulic motor and one of the mower's two fluid power cylinders are being operated simultaneously the "pressure control" feature of this valve self adjusts to meet pressure requirement of the cylinders while at all times providing the motor with fluid power.

THE RESULT: The constant operation of the sickle bar—even when the mower is being positioned to clear obstructions—eliminates jamming of the cutter bar due to a build-up of clippings.

The tandem assembly of separate valve sections in the COMMERCIAL directional control valve offers important plus advantages to manufacturers. It helps reduce inventories, provides for better mounting conditions, cleaner and easier piping, and simplifies servicing. Flexibility is extended by making it less costly to expand operating features through the simple addition of other working sections—without the need for a completely new valve assembly or a major change in mounting and piping.

YOUR PRODUCT, TOO, may benefit through outstanding fluid power advantages like these. Address inquiries to Commercial Shearing & Stamping Company, Dept. A-6, Youngstown 1, Ohio.

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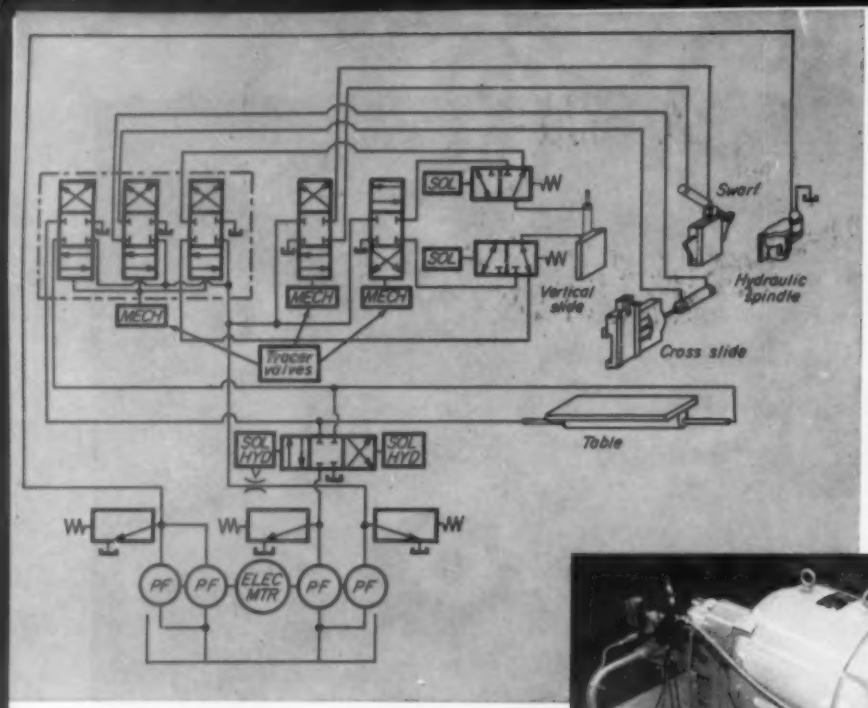
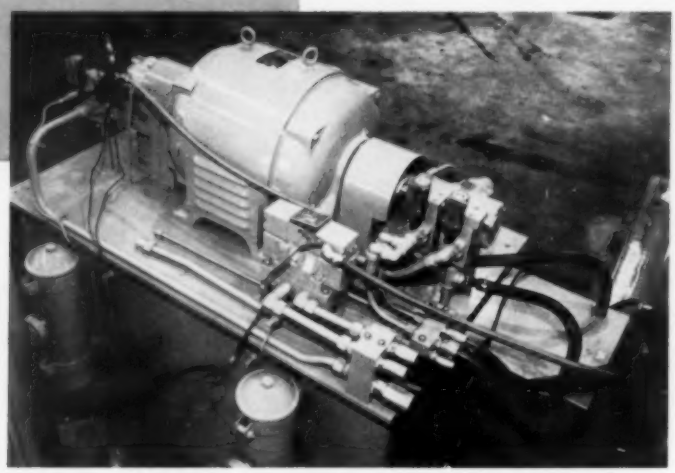


HYDRAULIC CIRCUIT showing divided reservoir and three tracer valves. One tracer controls cutter movement in vertical, cross, and horizontal directions. The second controls swarf attachment, the third is for positive depth control.

ONE TANK, TWO OILS—Hydraulic power unit has motor driving two double-element pumps. Reservoir is divided into two 100-gallon tanks. One holds oil for tracing circuit and the other for hydraulic spindle drive. Cooler at right handles by-pass oil returning to tank.



Separate circuits power spindle and tracers

● By EARL L. BRANE
President
Arrow Engineering Co., Inc.
Largo, Florida

Using a double-ended 50-hp motor to power the hydraulics on a contour milling machine makes it look like a single hydraulic system. Actually two different oils are used, so that the separation of circuits starts right back at the tank.

TWO 100 gal tanks are mounted in one housing. One tank is filled with a light oil for tracing; the other with medium weight oil for the spindle. A double-element pump at one end of the 50-hp motor delivers 16 gpm to the tracer control valves and 16 gpm for table rapid traverse. A tandem control valve unloads this pump through a cooler to tank when table rapid traverse is not being used. Tracing circuit operates at 300 psi and rapid traverse at 400 psi.

A dual element pump driven off the opposite end of the motor delivers 32 gpm to a 40-hp piston-type hydraulic spindle drive motor. The spindle motor runs at a constant 2000 rpm. A silent chain delivers power to the cutting head. Spindle speeds of 37 to 3000 rpm are attained by changing pick-off gears.

By changing speed with pick-off gears rather than metering flow, a constant hp is maintained at the cutting tool. At low speed 70,000 inch-lbs torque are available at cutting head for tough steel machining.

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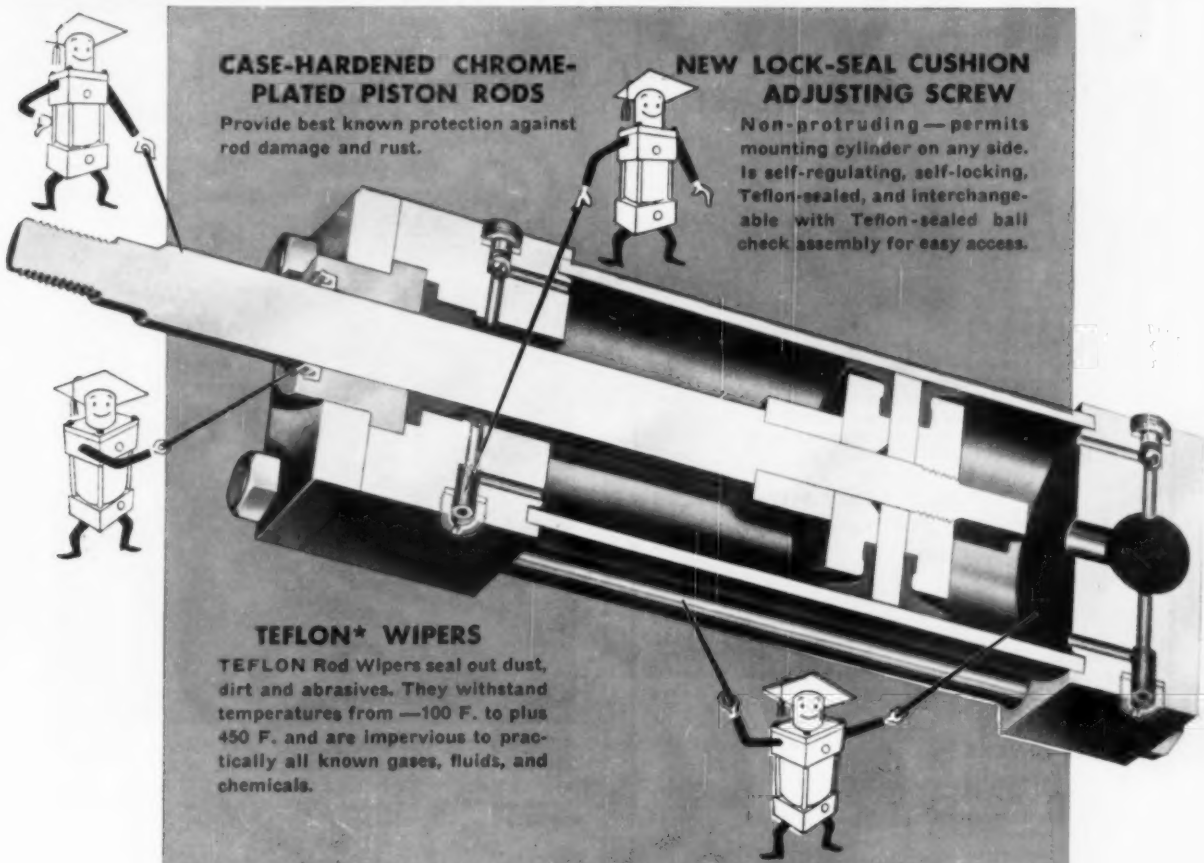

CASE-HARDENED CHROME-PLATED PISTON RODS

Provide best known protection against rod damage and rust.

NEW LOCK-SEAL CUSHION ADJUSTING SCREW

Non-protruding — permits mounting cylinder on any side. Is self-regulating, self-locking, Teflon-sealed, and interchangeable with Teflon-sealed ball check assembly for easy access.

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TEFLON Rod Wipers seal out dust, dirt and abrasives. They withstand temperatures from —100 F. to plus 450 F. and are impervious to practically all known gases, fluids, and chemicals.

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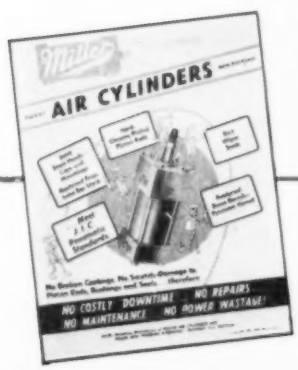
Highest Quality Rust-Resistant Coating provides extra protection during shipment, storage, installation, and operation of air cylinders. Cylinder heads, caps, mountings, pistons, followers, and the unplated portions of piston rods have this finish (not recommended for water service).

* duPont trademark for its tetrafluoroethylene resin.



Other Standard Miller Quality Features include: bar stock steel heads, caps, and mountings; rust-resistant brass barrels; self-regulating, wear-compensating piston rod seals that never require adjustment; space-saving square design; and other features as shown in Bulletin A-105 sent free on request.

Sales and Service from Coast to Coast . . .

Miller Air Cylinders are available in 1½" through 20" bores for 250 psi operation. Select from 19 standard mountings, strokes up to 22 feet, single and double rod end, cushioned and non-cushioned, and over-size rod cylinders. Large selection for immediate delivery.

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CHECKS

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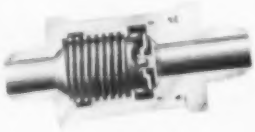
MINIATURE CHECKS

Mini-Valve Regular Size Valve

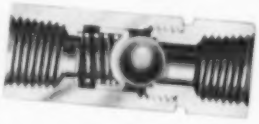
Save weight and space with Mini-Valves. They have same rated flow as regular size, but are only ¼ the size and weight. Good pressure drop characteristics. Temp. range −65° to plus 400°F. Operating pressure to 5000 psi. One-piece stainless steel body, in tube sizes 4 to 16 (¼" to 1" O.D.) Meets or exceeds requirements of MS MIL-V-25675. Port threading MS33514 flareless.



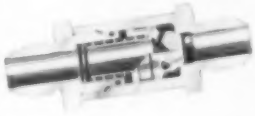
FREE-FLOW CHECKS

Extremely low pressure drop, with wide open flow. Molded elastomer seal and spherical seat prevent leakage at any pressure. Sizes ⅛" to 2" in brass and aluminum alloy up to 3000 psi, and stainless steel to 4000 psi. Opens at 2 psi. Temp. range −65° to 200°F. Pipe, internal straight thread and flared tube connections standard; MS33514 flareless available.

BALL CHECKS



Ruggedly constructed for intermittent non-shock hydraulic service up to 500 psi at temperatures −65° to 350°F. Sizes ⅛" to ¾". Brass, aluminum alloy, stainless steel. Pipe and flared tube connections.



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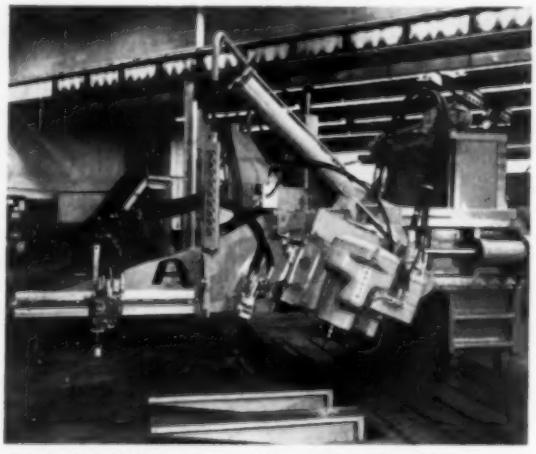
SEPARATE CIRCUITS

• **Stationary Table Cylinder**—The 42-inch by 12-ft table is driven by a 6-inch cylinder with a 136-inch stroke. The cylinder is attached to the table and moves with it. Rod has two sections coupled at the piston and attached to the bed at both ends. Oil is piped into the outboard ends of the hollow rod and ported into the cylinder on both sides of the piston. Neoprene cups are used for piston seals and chevron packing for rod seals. Cross cylinder is 6-inch dia and has 48-inch stroke. Vertical cylinder is 5-inch dia and 12-inch stroke.

• **Main Tracer valve**—A 3-dimensional tracer valve regulates flow to all three drive cylinders. Feeds up to 75 ipm are possible by adjusting flow at the valve. Operator traces around a template with the valve stylus and the cutter traces a similar path on the work. Duplicating accuracy is within .005 inch. Needle valves on the tracer give positive lock-off for any direction of travel, permitting straight milling cuts without using a template.

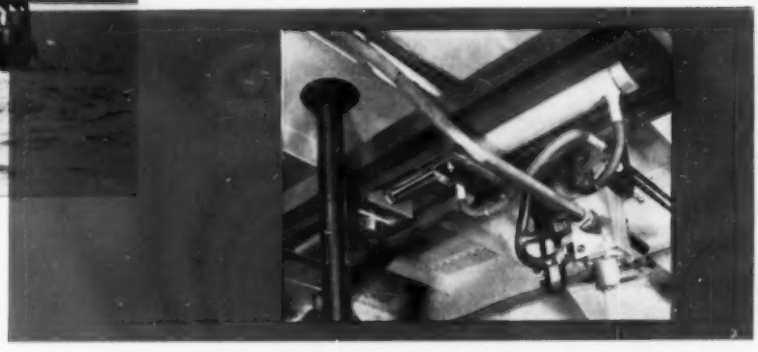


SWARF ATTACHMENT machines twist cuts 200 degrees either side of vertical. Swarf is powered by a 5-inch diameter cylinder which is controlled by a 180 degree tracer valve operating on a two-dimensional rise-fall template.

• **Spiral Milling**—An attachment called a swarf rides in circular ways on the crosshead and permits the cutter to pivot through a 40 degree arc. A 5-inch diameter cylinder drives the swarf. It is controlled by a separate 180 deg tracer valve which rides on a two-dimensional rise and fall template. Accuracy is within one minute.

• **Depth Control**—For positive depth control a third tracer valve operates on an adjustable six-position turret stop. Depth limits are set with the stops and accuracies are held to .001-inch. Pressure on bottom or side of valve stylus raises the cutting head. This lets the operator rotate the turret stop into side of stylus and cutting head will rise until stylus is seated on top of stop. □□□

'Delta', owned by the Westminster Dredging Company Ltd., uses Keelavite hydraulic equipment for many purposes including steering.



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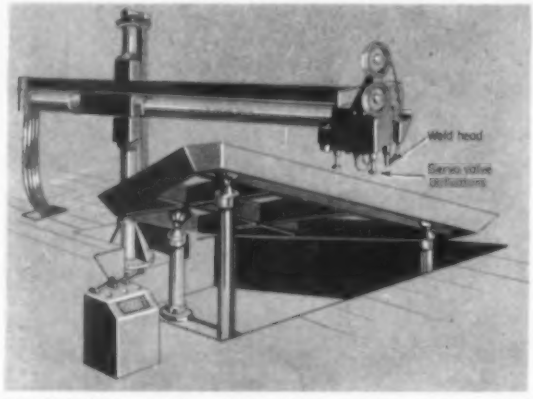
581A

Servos level 8-ton load

• By L. E. FARNSWORTH, *Automation Machines & Equipment Co., Inc., Milwaukee, Wis.*

This article was awarded a prize in the 1958 APPLIED HYDRAULICS & PNEUMATICS Prize Paper Contest.

THREE cam-actuated servo valves keep mammoth turbine blades level while a hard surfacing metal is welded on them. The blade fastens to a tilting platform. A motor-driven, spring-loaded, knurled wheel drives the head along the blade at constant speed. To position the blade and maintain a level surface at the point to be welded, the platform is elevated and tilted as much as 30 degrees in any direction by three double-acting cylinders connected in a servo system. Each cylinder has a 6-ft stroke with 3 ft of rod remaining in the cylinder to absorb side thrust.



PLATFORM in tilted position. Piston rods are connected to platform through ball joints allowing free movement about any plane.

Cylinder rods are connected to the platform through ball-joints. One of these ball-joints is fixed to the platform, the other two are mounted in slides which permit them to move in any direction as dictated by the tilt.

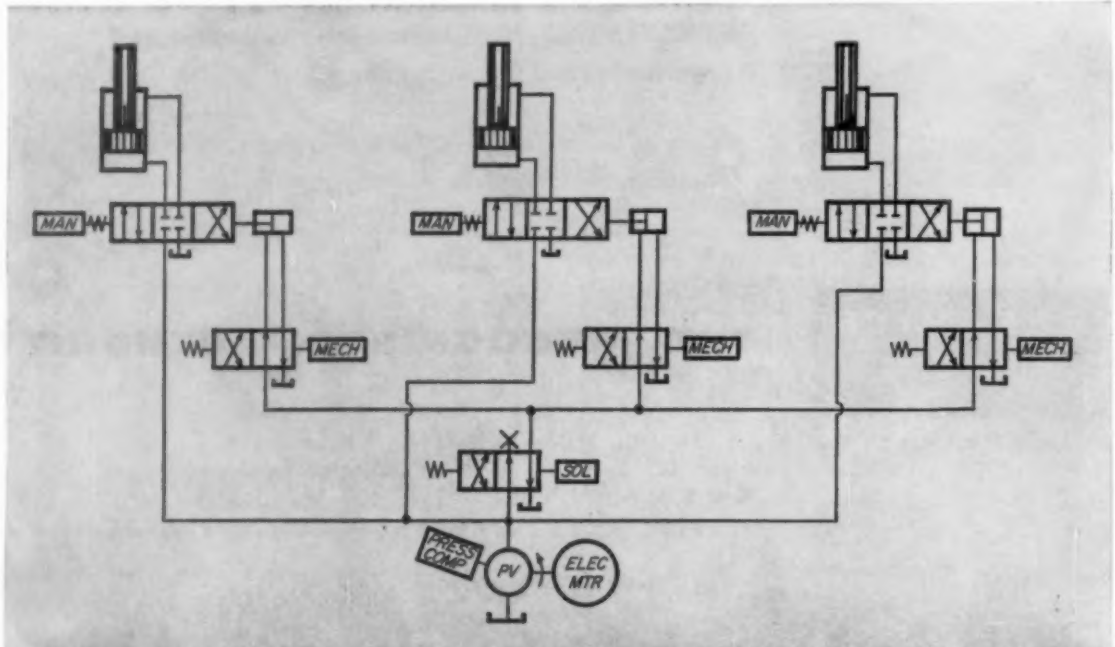
Oil is supplied to the unit by a 70-gpm pump mounted on a 200-gal reservoir. A console houses the control valves and the main electrical control panel.

• **Servo System**—Blade surfaces are kept level at point of welding by a 3-valve servo system. There is no need for an elaborate signal system because high degree of level accuracy is not required.

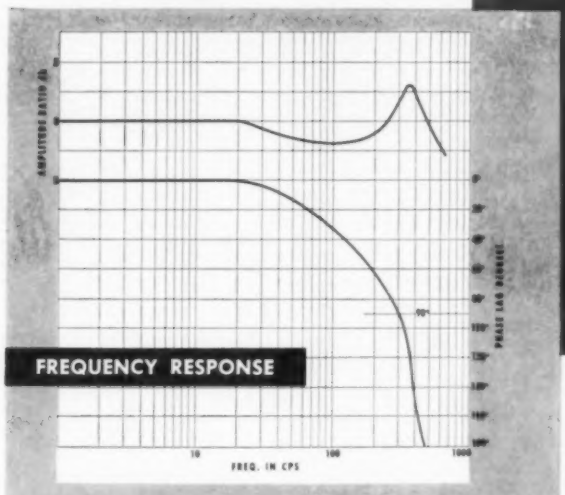
The servo valves are standard, cam-actuated, lapped to slightly negative port openings to insure constant pilot pressure with very little deflection. Hardened steel rollers on the push rods follow the blade contour. Rod extensions actuate limit switches.

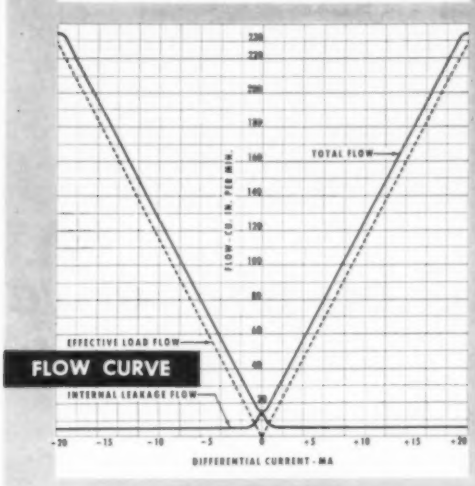
Manual control of the main valves raises the table until limit switches activate pilot lights, indicating cylinders are in position. When all three limit switches are tripped, a solenoid valve is actuated directing pump output to the servo leveling circuit. If one of the actuators travels off the blade edge, the solenoid valve shifts and stops the table. □□□

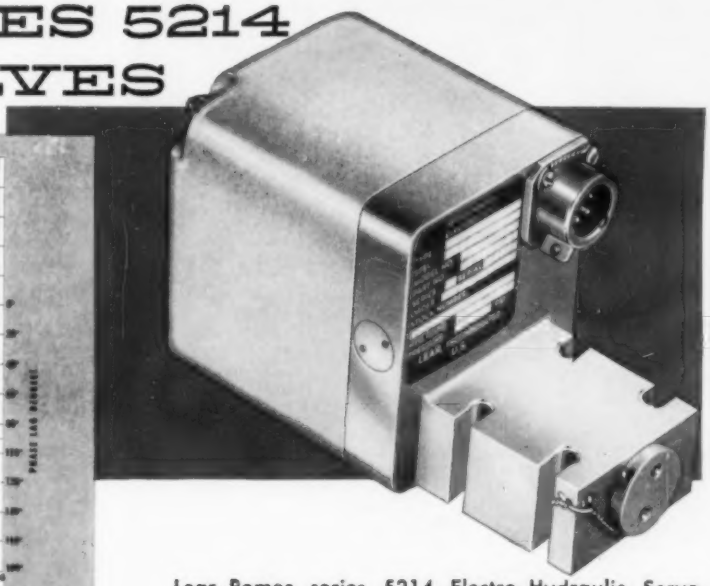
HYDRAULIC CIRCUIT for positioning platform. Rollers on servo valves follow contour of work, raising and lowering table cylinders to keep work level.



LEAR SERIES 5214 SERVO VALVES







Lear-Romec series 5214 Electro-Hydraulic Servo Valves were developed to meet the rigid requirements of aircraft and missiles. They are reliable, high performance flow control valves for use as guidance or control transfer units where high speed response is required. In low flow applications excellent phase and amplitude responses are obtained. The simplified direct drive design of this valve provides an exceptionally reliable servo valve with flow outputs to one gpm.

The Lear-Romec valve, illustrated schematically, is a single stage, four-way spool type electro-hydraulic flow control servo valve. It consists essentially of a permanent magnet torque motor, a linkage and the spool. The electrical input signal is received by the torque motor whose output is applied through the linkage directly to the four-way spool. The torque motor runs dry and is therefore not subject to any contamination by the fluid. This direct connection between the torque motor and output spool provides excellent dynamic characteristics and linear flow control. Contamination problems of this valve and internal leakage is reduced to a minimum.

The 5214 servo valve is being provided for a range of output flows from 25 cu. in. per min. to one gpm. It is also being provided for pneumatic applications. For special applications please contact the Contracts offices listed.

ENGINEERING DATA

Rated Flow	1 gpm at 3000 psi & 20 m.a.
Flow Range	.25 cu"/min. to 1 gpm
Operating Pressure	200 — 3000 psi
Weight	12 ounces
Internal Leakage	15 cu"/min. maximum
Coil Resistance	1570 ohms each coil
Electrical Input	20 m.a.
Natural Frequency	330 cps
External Leakage	None
Operating Temp. — Fluid	—65°F to 275°F
Operating Temp. — Ambient	—65°F to 275°F
Dither Required	None
Recommended Filtration	10 micron
Hysteresis	3%
Proof Pressure	Supply — 4500 psi Return — 3000 psi

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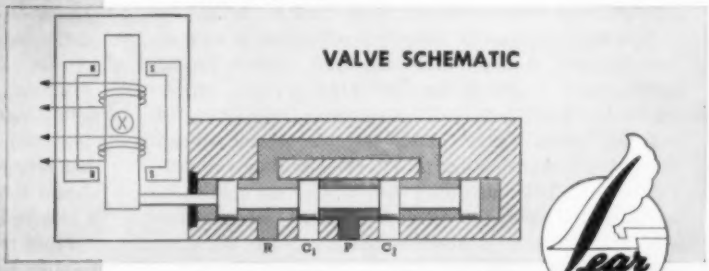

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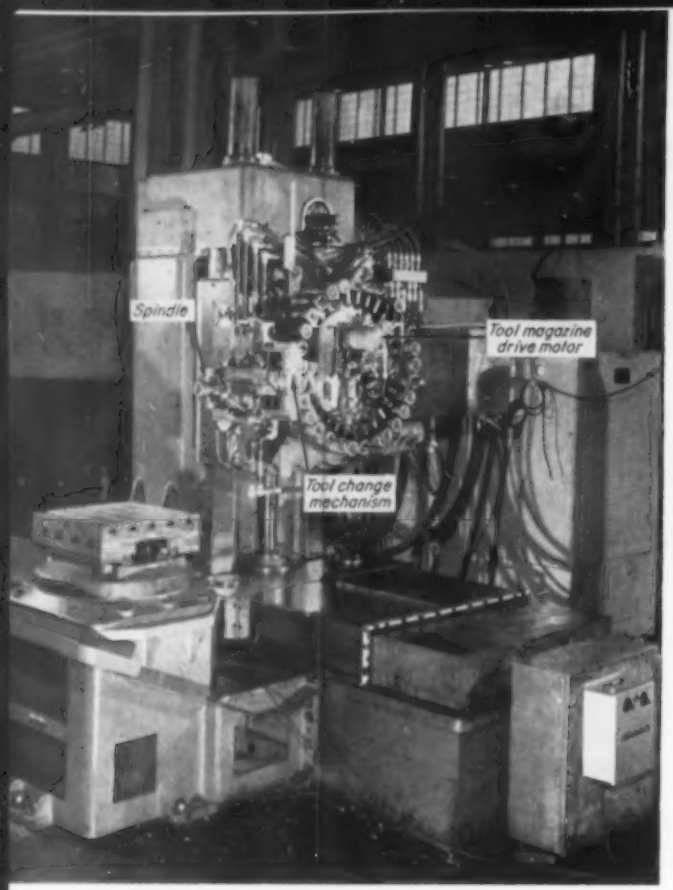
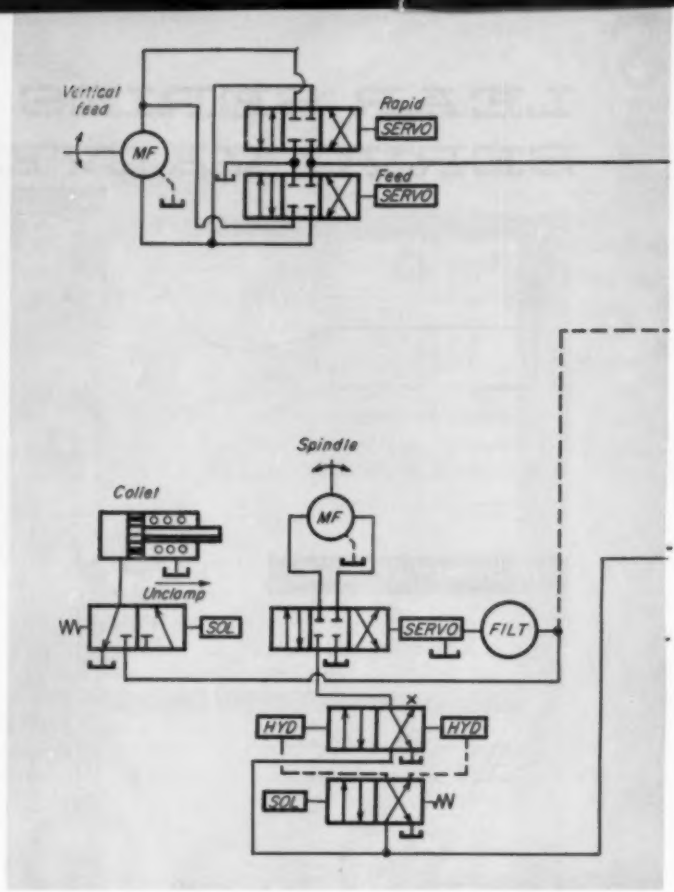




Servo-controlled fluid motors drive

● By ROBERT K. SEDGWICK, *Assistant Chief Engineer, Servo Machine Tool Div.,*

"SERVO VALVES are the hi-fi elements in a machine tool. It's the designer's job to raise performance of the rest of the machine to make the best use of the servo valve." With that in mind, Kearney & Trecker designers have used fluid motors, controlled by servo valves, to drive the tool slides and spindle of their new, tape-controlled, multi-tool machine.

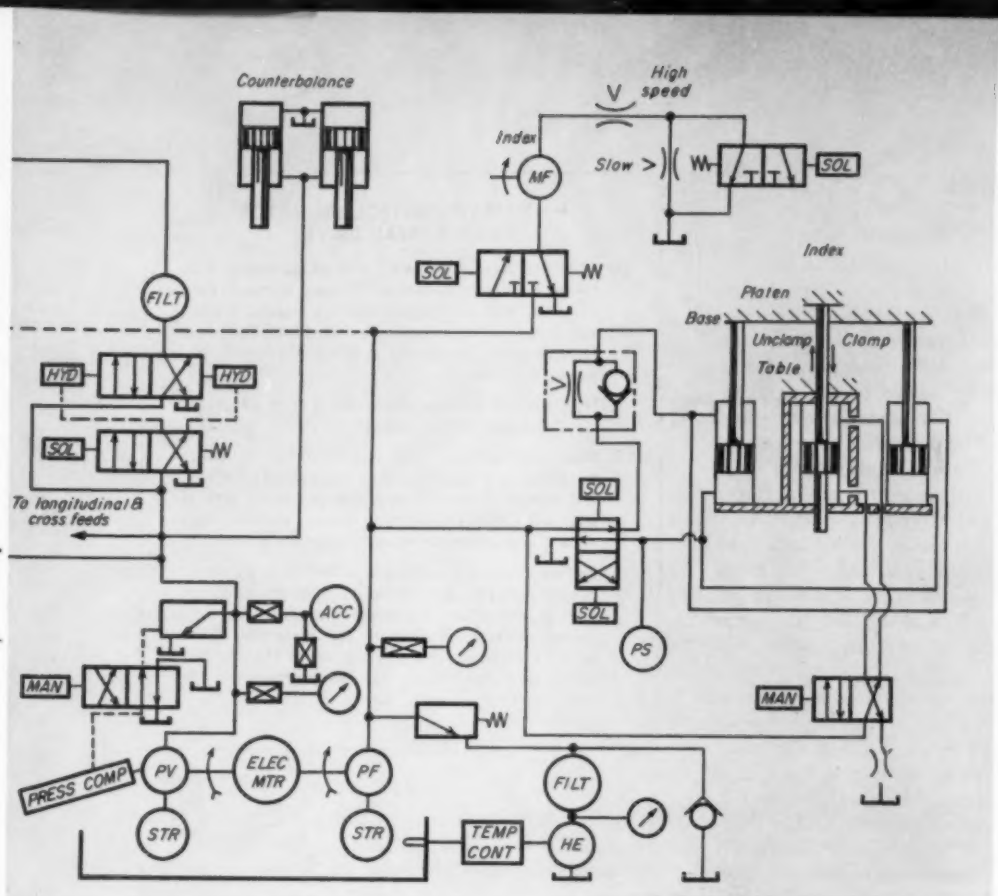
The machine has 32 tools in a magazine. It can select any one of these (end mill, drill, reamer, tap or boring tool) insert it into its spindle, select proper speed and feed, and perform the operation. Parts of different sizes and shapes can be programmed through the transfer line in either mixed or consecutive order. This flexibility has a big advantage in medium and small lot runs producing parts for immediate assembly without waiting for the complete lot of each type.

• **Why Fluid Motors?**—An axial piston motor with a fixed displacement of .96 cu. in./rev. and torque rating of 152.5 lb-in/1000 psi drives each of the three slides through re-circulating ball screws. This design gives an excellent combination of stiffness, high response, and low friction. These advantages are especially important when compared with previous designs.

Formerly, many servo-controlled milling machines had long cylinders moving the slides. When the servo valve made its appearance, the big switch was to ball screws, and more attention was paid to the dynamics of the machine, such as analyses of the spring rates for the different power trains.

Mounting the ball screws so they are restrained at both ends improves the rigidity. With the servo valve close-coupled to the motor, the small amount of oil under compression reduces the compressibility effects almost to zero. The machine slide goes exactly where it is supposed to go, in the time allowed.

Fluid motor drive also gives accuracy both in positioning the slide and repeating with extremely low error. Our first group of machines using this arrangement could position within .0002 in. time after time, under various cutting loads. Accuracy depends on speed of approach, friction, backlash, and all the other imperfections in the system. It also depends



TO CHANGE TOOLS, magazine rotates and electrical fingers sense grooves on tool holders. When signal from fingers matches command signal, magazine stops. Tool swings out parallel with tool in spindle. Tool change mechanism also swings out and rotates, replacing tools.

FLAPPER NOZZLE VALVES control tool slides, spool type valve controls spindle. Rapid servo valves controlling feed motors are overlapped and act like regular 4-ways to give fast traverse. Spindle motor and clutches provide 99 speeds from 100 to 4500 rpm. Variable volume spindle motors are used in larger machines to keep up power at lower speeds and still allow high speed operation.

multi-tool machine

Kearney & Trecker Corp., Milwaukee, Wis.

on the servo valve. The valve with the best performance near its neutral position gives the best results when creeping the slide to an exact position. Some of our recent machines have positioned 50 consecutive times with a maximum error of .0002 in.

Acceleration of the slide from a standing start is extremely good with this design, because of the low inertia of the motor and the other rotating components in the gear train. But it is not as good as with a cylinder, and it falls off rapidly as the flow rate approaches the capacity of the valve. Some compromise is necessary in selecting the valve, because if it is too large, performance is poor near its neutral point. Hydraulic drive is much better than any electric drive or drives having change gears and clutches.

Response of the servo valve to changes in signal level is so prompt, and accurate, that corrections are made almost as soon as they are detected by the feedback device. A slide, controlled by tachometer feedback, may be slowed momentarily by a slight change in friction or cutting load, but the detection and correction are so rapid that the error lasts only a very short time. Velocity change is usually negligible. The slight motion which is lost is made up by the signal from a position feedback, if position is important. This close regulation shows up in better finish, closer tolerances, and increased cutter life.

• **Selecting Servo Valves**—The servo valve which controls the spindle drive motor is a 2-stage spool type unit, specifically designed for industrial applications. Deflection of its torque motor is transmitted to the pilot stage by a stiff, connecting wire, so that mechanical displacement of the pilot spool is directly proportional to the error signal. Full deflection is .020 in. to either side of null position. Movement of the pilot spool ports fluid to unbalance forces on the main spool and shift it accordingly.

A feedback linkage connects the main spool and the pilot spool sleeves. When the sleeve moves to the position of the pilot spool, pilot flow is shut off, and the valve remains in this position. A variable fulcrum on the linkage permits selection of the best linkage ratio for each application. Maximum flow rating is 18 gpm at 3000 psi supply pressure. A dither of 60 to

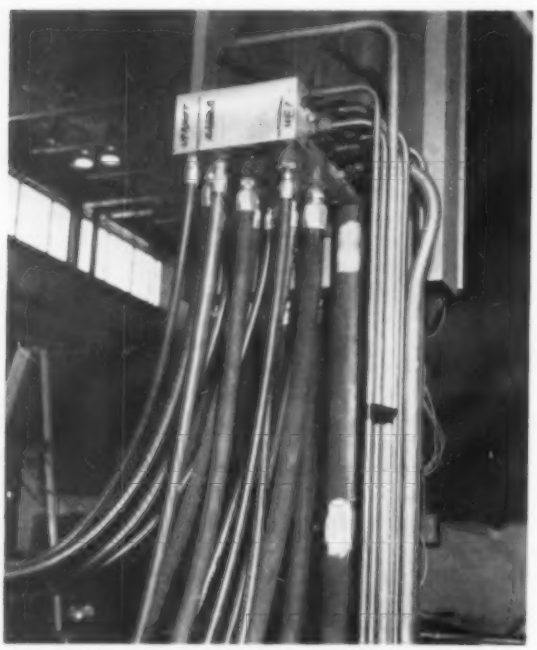
400 cps is recommended.

The servo valves which control the tool slide drive motors have flapper-nozzle first stages and spool type second stages. As a signal is applied to the torque motor, it pivots the flapper between the nozzles. This opens one orifice and closes the other producing a differential pressure between nozzle chambers. This pressure difference acts on the second stage spool shifting it against springs. The pressure difference also acts on the nozzle projected areas resulting in a feedback force on the flapper to balance the motor force.

• **Valve Performance vs. Strength**—Flapper-nozzle valves frequently have aluminum bodies with steel inserts and small screws, closely spaced. This gives compactness and light weight, but some of these valves are simply not strong enough, and we have had some spectacular wrecks because of pressure surges, especially at the tank port.

The pilot-spool type valve usually has lots of material for strength, plenty of room for large screws to hold the assembly together, and room for more large screws to mount the valve securely to the motor.

Our experience with flapper nozzle valve performance has been excellent, particularly dynamic characteristics. The flapper-nozzle arrangement gives good response at quite high frequencies, and this results in improved machine performance. Linearity between current and flow for the flapper-nozzle valve is excellent especially near zero deflection, where much of the accurate work is done on a milling machine.



MOST OF THE HYDRAULIC POWER is delivered to the machine through hoses. The large number of connections would have made rotary joints impractical. Aluminum manifold block is shown at top.

WHY SERVO CONTROLLED MOTOR MAKES IDEAL DRIVE

1. Ability to accelerate rapidly with small torque. This leaves more torque for accelerating machine slide and load, gets the slide where it's needed rapidly, and stops it with minimum overshoot. Extremely rapid response permits quick speed adjustment, improves regulation.
2. Fluid-motor/ball-screw mechanism is stiff, withstands rapid changes without appreciable elastic deflection.
3. Servo valve permits small amount of electric power to control very large amount of hydraulic and mechanical power. Control components are small both in size and capacity, permitting printed circuits, transistors, and encapsulation of electronic elements.
4. Performance can be improved within limits by simply raising pressure. Duty cycle of fluid motor is very low, so motor can be driven very fast for short periods without reducing its life appreciably. Most of the time servo valve throttles oil, so that pressure at motor is low. Motor has full pressure for only small fraction of total time.

As a signal is applied to the valve, it begins to move and changes the flow conditions. This is called the *threshold* point. Everyone wants it to be as near zero as possible. To get this the valve should have very little friction. The flapper design is ideal in this respect because the flapper does not touch anything.

Sometimes a valve drifts over a period of time in response to temperature changes and other disturbances. This moves the neutral or null point, and current must be applied to correct for the motion. Because there is so little to the flapper, it cannot change much with temperature. Also the length change of the flapper does not change its lateral position. In comparison, length change of the primary stem in a pilot spool changes the spool position, unless the body changes exactly the same amount.

• **How Clean for Servo Valves?**—One belief about servo valves for machine tools that we have found to be untrue is the matter of dirt in the system. We took a number of precautions such as building a special tube-washing device for cleaning all tubes before they are installed, but we found we could do without it. Only ordinary cleanliness is necessary for the tubes, the same as any good hydraulic system. We have provided filtration as specified by the valve supplier.

• **Air Heat Exchanger**—An unusual feature of the supply system is the use of a radiator to reject the heat developed from metering in the servo valves. It gets rid of about 12 hp continuously and about 16 hp during peak loads. The main advantage of this arrangement is water saving. This is very important when this machine is used by the aircraft industry which is located mostly in the coastal, water-scarce areas. Temperature is held to 110 F with 150 SSU oil. □□□

Circle 109

Is air free?

No, not when it's compressed and put to work. And, wasted air adds hidden costs to manufacturing expense. Excessive air consumption by air control valves—especially "cross-bleed" or air lost to exhaust during valve shifting—can overload compressors and boost air supply costs.

Recent tests show that Valvair Speed King control valve air consumption, under identical conditions and at average operating speeds, is as much as 30 cfm less than competitive valves. With today's air costs of up to $.10 per 1,000 cu. ft., Valvair's reduced air consumption can save over $300. annually *per valve*, in air costs alone!

Before you buy any air control valve . . . compare air consumption and operating cost . . . compare performance . . . compare life . . . compare ease of maintenance . . . compare guarantees . . . compare, and you'll buy Valvair!

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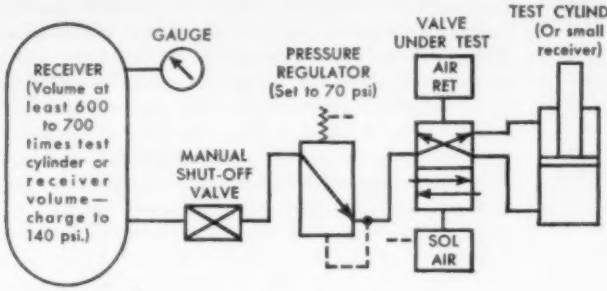

MAKE THIS SIMPLE TEST—connect the valve to be tested as shown, operate it at approximately 150 cycles/min. until receiver pressure drops from 140 to 90 psi and count the number of cycles operated on identical amounts of air. You'll find that Valvair Speed Kings will outperform other valves by as much as 6 to 1.

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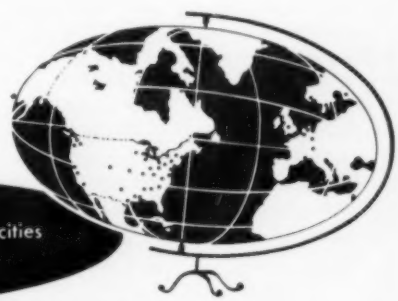

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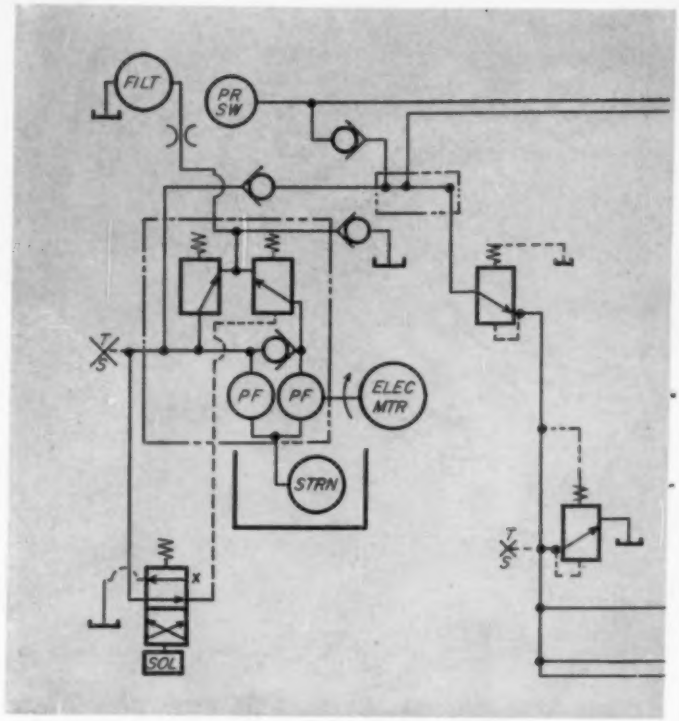
Counterbalance control with servos

• By RALPH L. FORD,
Chief Designer
Planer Type Milling Machines,
Giddings & Lewis Machine Tool Co.,
Fond du Lac, Wis.



Servo performance of this milling machine is not as critical as many systems, but it has made the difference between tool drift and an accurate cut.

MAKING a straight cut on a planer type milling machine has been a problem when the top head moves transversely across the table. The problem is even worse when cutting parallel paths with two or more heads. Long screws support the cross rail at each side housing and permit vertical positioning. As the heads move across the rail and change tension on the screws, the rail tilts. A long screw may change its length as much as .008 in. when the heads move from one side to the other. Clamping the rail has not worked, because no reasonably sized friction clamp can hold the weight, especially when the cutter vibrates the machine frame at high frequency.

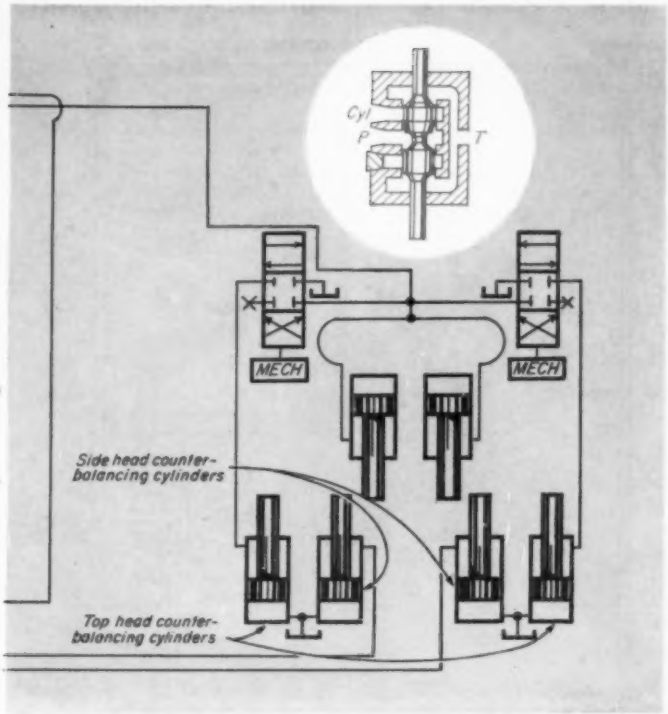
The servo system in a machine developed by Giddings & Lewis controls a counterbalance which relieves the weight of the heads from the cross rail and transfers it to the frame of the machine. The rail elevating screws only have to hold the rail weight and position it to its various heights. This leaves the rail elevating screws free of variable loads.

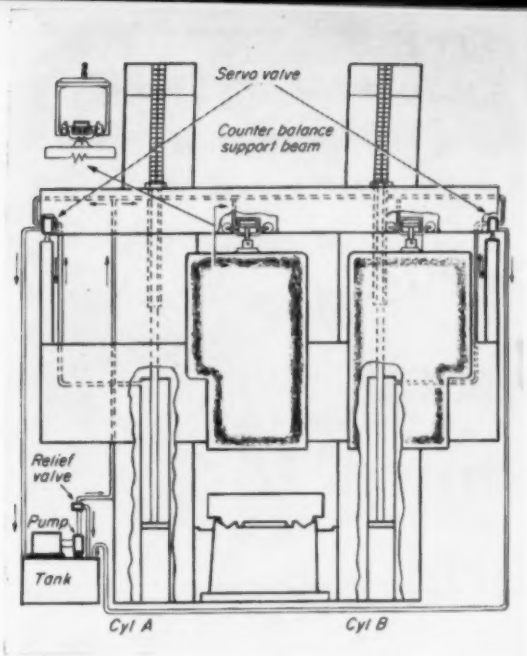
• **Mechanical design**—Each head is hung from a trolley which rides on the counterbalance beam. The head is attached to a small cylinder in the trolley. Pressurizing the rod end of this 4⅞-in. dia. cylinder produces an upward force of 8650 lb. at 630 psi (normal system pressure). The 1-in. stroke of the cylinder allows for changes in distance between the beam and cross rail as they move up or down together. Spherical washers between the cylinder and the trolley platen prevent piston binding because of misalignment between counterbalance and rail. A straight dowel pin fastens the head to the piston, so that the trolley and cylinder are free to swing in a plane along the length of the beam.

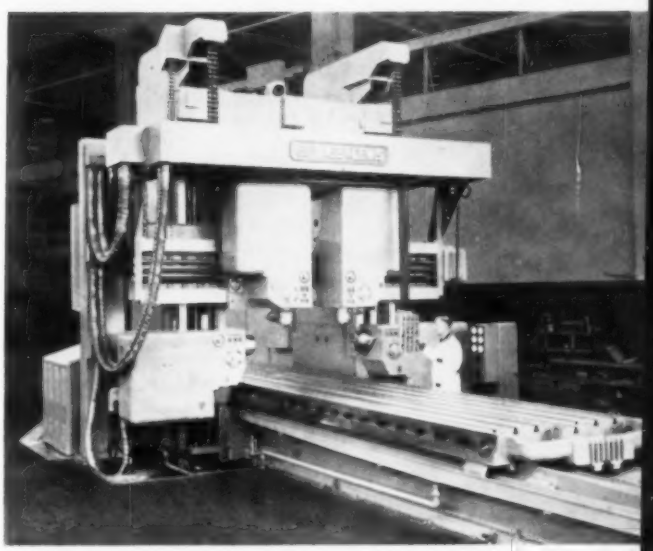
The counterbalance beam is suspended from two chains which run over sheaves on top of each side housing and connect to the piston rods of counterbalancing cylinders mounted inside the side housings. These cylinders are controlled by the servo valves to raise or lower the heads. A 2-head machine has 8-in. cylinders with 3½-in. dia. piston rods. With full pressure of 630 psi, each side lifts approximately 26,400 lb which is the total weight of both heads plus most of the weight of the counterbalance beam.

• **Hydraulic design**—A mechanically actuated servo valve at each end of the counterbalance beam controls position of the beam relative to the cross rail. Pressure of 630 psi is applied to the inlet port of each valve. When the rail and heads are parallel, the valve spool blocks pressure and cylinder ports. A change in dimension of .003 to .005 in. between either side of the counterbalance beam and rail shifts the servo valve to pressurize or drain the counterbalancing cylinders.

The servo valve body bolts to the beam, and its spool attaches to a bracket on the cross rail. Spool shift is 5/16 in. each way from center position. During rapid traverse up or down, the valve must open







CYLINDERS COUNTERBALANCING TOP HEADS are controlled by servo valves. Cylinders counterbalancing side heads are under constant pressure controlled by pressure reducing valve and sequence valve.

SUSPENDING HEADS from counterbalance beam relieves weight from screws which raise cross rails. Servo valves and counterbalance cylinders keep heads level.

wide enough to raise or lower the heads at the same rate as the rail. This usually requires $\frac{1}{8}$ to $\frac{3}{16}$-in. spool travel.

The servo valve is a modified, 4-way, spool valve with one port blocked. The land at port *B* is tapered to give controlled application of pressure to the cylinder.

Two additional cylinders in the end housings counterbalance the side heads. Pressure fluid is applied to the rod ends of these cylinders directly from the pump. Discharge (side heads moving down) is through a sequence valve. Outlet pressure from a pressure reducing valve is applied through a check valve to the sequence valve. The sequence valve is hydraulically balanced, held closed by a light spring. This arrangement permits fine pressure adjustment.

• **Design problems**—One of the bugs in perfecting this system was the servo valve. The original unit was spring-loaded with its spool riding on the rail bracket. Because it operated with very little movement, the spool would silt up. The silt would cause enough drag on the spool so that the spring would not shift it, and the valve would fail to open when the rail was lowered quickly. This would keep each actuating cylinder blocked so the end nut would be stripped from the piston rod. Eliminating the spring and fastening the spool to the supporting bracket gave the positive action required to shift the valve.

Oscillation was another problem which developed on wide machines with a long span between chain supports. This happened when the rail was lowering with the heads centered. A stiffening beam installed on top of the main beam eliminated the oscillation.

This system of counterbalance is superior because it gives a slight over balance on the heads. The cutting tool has a rigid bearing to the machine frame without loose bearing surfaces which can set up chatter. It relieves the rail bearing surfaces of excessive loads, eliminating hardened insert strips. It also prevents the overhanging heads from twisting the rails, and increases machine accuracy. □□□

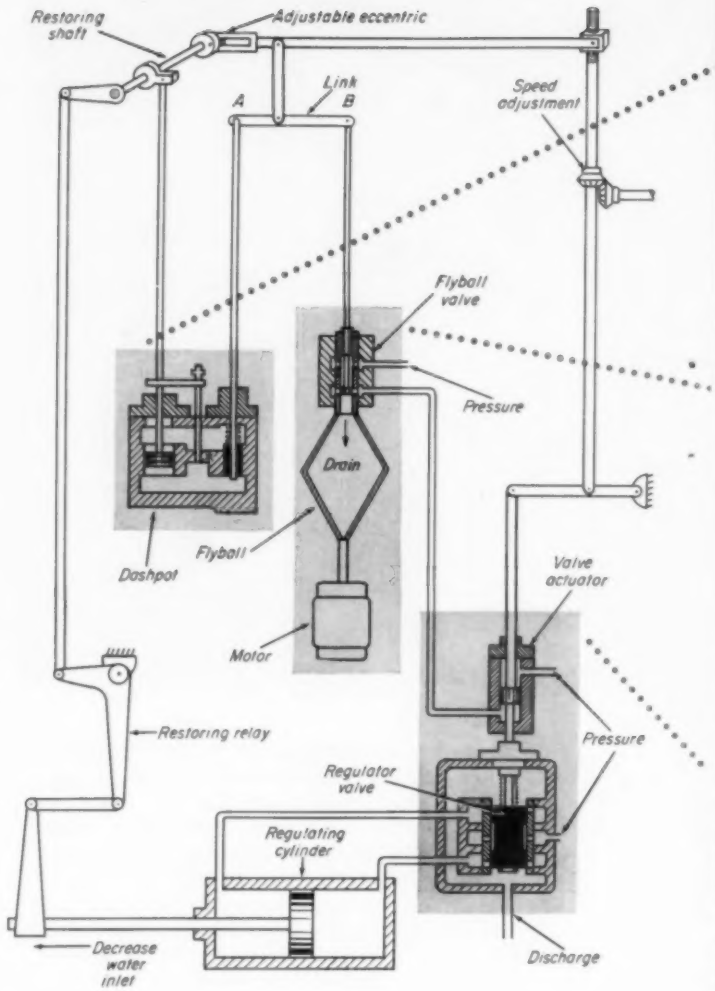
Servo speed control for turbines

● By B. R. NICHOLS,

Engineer in Charge, Mechanical Design, Hydraulic Turbine Dept., Allis-Chalmers Mfg. Co., Milwaukee, Wis.

and LEE N. MOCKRUD,

Keystone Pipe & Supply Co., Milwaukee, Wis.



WATER turbines driving electrical generators must be closely speed-controlled to maintain exact frequency. As system load (current) changes, the generator tends to speed up or slow down. Hydraulic governors sense speed changes with a fly-ball unit which actuates valves to control regulating cylinders. These cylinders control water flow to the turbine.

In the design shown here, the fly balls are driven by a synchronous electric motor powered from the system. An increase in speed forces the fly balls out and shifts a sleeve in the fly-ball valve to drain the underside of the valve actuator. Because pressure is always applied to the top of the differential valve actuator piston, it moves down shifting the regulating valve.

The regulating valve directs oil to one or two cylinders which extend to close off water flow to the turbine. Movement of the cylinders is fed back through a mechanical linkage to the spool of the fly-ball valve where cylinder position is *mixed* with turbine speed to close the servo loop.

To prevent over-correcting and hunting, the dashpot limits speed of the follow-up movement on the fly-ball valve, so correcting movements are a series of small responses rather than one large movement. The adjustable eccentric (speed droop mechanism) regulates amount of cylinder travel for a given speed change.

● **Governor Sensitivity**—With increasing interconnection of electrical transmission systems, governor requirements have increased to keep generators coordinated. Until about 10 years ago, sensitivity (per

DASHPOT momentarily amplifies motion of feedback system to improve stability and provides adjustable rate of return of feedback ratio to normal mechanical ratios. Rate of return is adjusted by needle valve, and should be same as rate of deceleration or acceleration of turbine.

Large piston moves at same rate as regulating cylinder. Small piston also moves approximately at this rate until large piston stops. Spring then returns small piston to center position at rate adjusted by needle valve.

Small holes in piston give faster response when returning to center, until piston is about 1/16 in. from center. Slower rate of return improves system stability.

FLY-BALL UNIT consists of fly-ball mechanism and valve. As speed changes, fly balls move in or out shifting valve sleeve up or down. Outward movement of fly balls (increased turbine speed) pulls sleeve down to drain pressure oil from valve actuator. Inward movement of balls (decreased turbine speed) pushes sleeve up, connecting pressure oil to actuator.

Pilot spool is connected through dashpot to mechanical feedback system and shifted according to cylinder position. When cylinder position (and water inlet to turbine) agrees with speed setting of governor, valve sleeve and spool close off connection to actuator.

REGULATING VALVE AND ACTUATOR is 4-way unit controlling flow to cylinders. Stem connects valve to actuator. Special washer holds valve spool against shoulder of stem. Locknuts are tightened to allow .0025 in. clearance between spool and washer. Upper locknut is then doweled to stem. Spring eliminates end play and still allows valve spool to center itself in bore of bushing without binding or strain.

Actuator has differential piston positioned by pressures acting against each side. System pressure is applied to small annular area on top of piston; pressure on bottom area of piston is applied or drained by the fly-ball valve. Closing locknut limits rate at which cylinders can close gates.

cent speed change required to start movement of turbine gates) of ¼% was good practice. Today, however, governors must respond to speed changes from $\frac{1}{25}\%$ to $\frac{1}{100}\%$ or $\frac{1}{40}$ to $\frac{1}{67}$ of one cycle.

In most governor systems, the linear motion of the fly-ball unit is transmitted mechanically through a system of light weight floating levers to a pilot valve which positions the regulating valve. However, small changes in joint friction can be large in relation to the small amount of energy available from the fly balls, and this causes inaccuracies.

By transmitting the fly ball motion hydraulically to the regulating valve the system can use relatively large, rigid levers. Normal joint friction in this type of system is a small percentage of the available thrust. □□□

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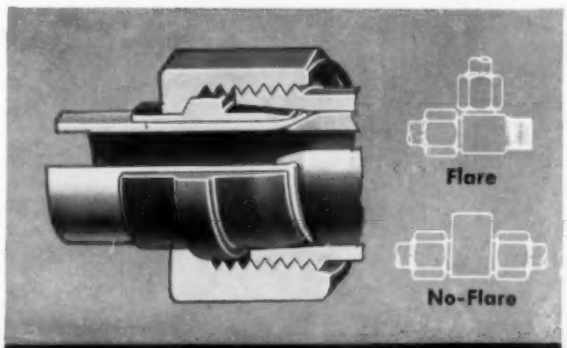

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- Easy Assembly — "Rock Bottom" stop signals that joint is sealed.
- Double Seal — seals on both OD and ID of the tube.
- Lower Cost — FLODAR'S Self-Flare fittings cost less to buy and install.

You can gain the advantages of both flare and no-flare fittings with none of the disadvantages . . . when you switch to FLODAR Self-Flare tube fittings.

Tube shearing and work hardening are eliminated . . . FLODAR Self-Flaring fittings can be reassembled time after time without fear of leakage or damage to tube and fitting.

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DESIGN

As missile programs passed from early development to production, servovalves of increased sophistication became necessary. Keeping pace with this development, Moog has been responsible for all major servovalve improvements.

FIRST ▶

nozzle-flapper servovalves*

double-nozzle servovalves*

dry motor servovalves*

volume producer of double-nozzle mechanical feedback servovalves†

*Patented †Patent Pending

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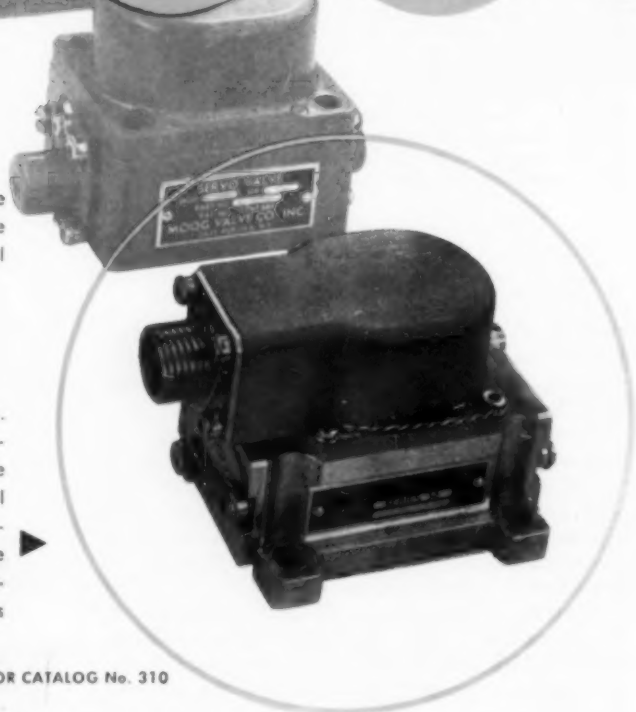
continued progress from



PRODUCTION

The 80,000 Moog servovalves produced to date represent a production record unmatched in the industry. Moog is the major supplier to virtually all missile programs.

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Today reliability is the key requirement for missiles. Anticipating this need, Moog has had under intensive development and test for the past year the simplest, lightest, most compact and reliable of all production servovalves. Its performance in all important respects exceeds that of any other available unit. Moog is pleased to announce immediate availability of the new Model 31 and 32 Series valves in quantity to your specifications. ▶

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FEBRUARY 1959

AVIATION SECTION

ROTARY SERVO VALVE FOR AIRCRAFT APPLICATIONS 100

By Jacques Faisandier

To keep leakage low at high pressures, spool valves had to have small clearances. This caused a problem of sticking, so French designers developed a rotary valve. A special torque motor and potentiometer adapts it to electro-hydraulic systems.

MACH 3 BY '63 102

A report of the recent Vickers' Aero Hydraulics Conference. Comments on future requirements for transport aircraft and space vehicles. How Convair's 880 was made more reliable.

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AVIATION COMPONENT DATA 108

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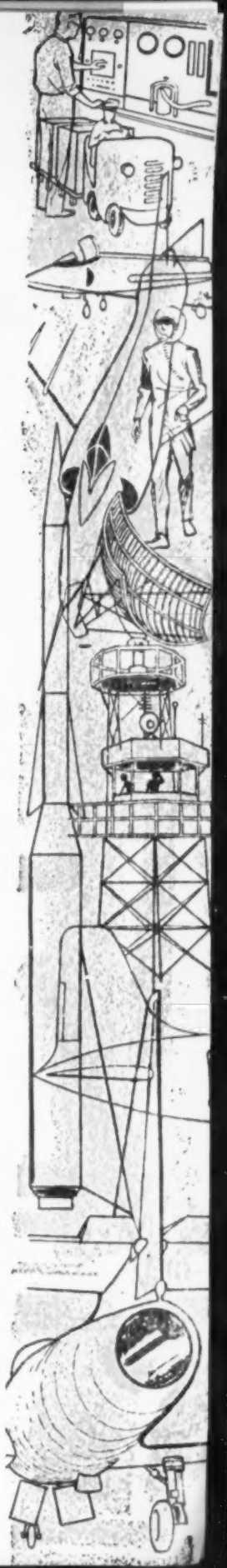


Rotary servo valve for aircraft applications

• By JACQUES FAISANDIER *Technical Manager,*
Societe D'Applications des Machines Motrices, Paris, France

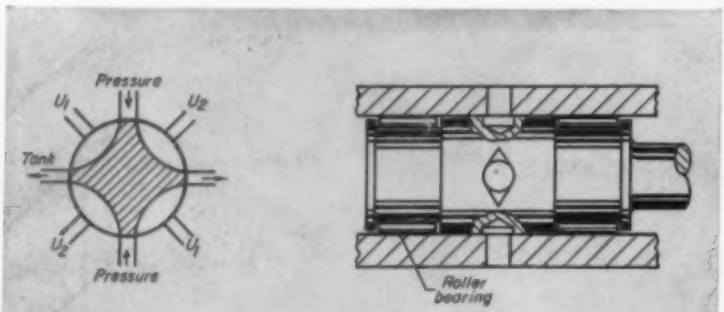
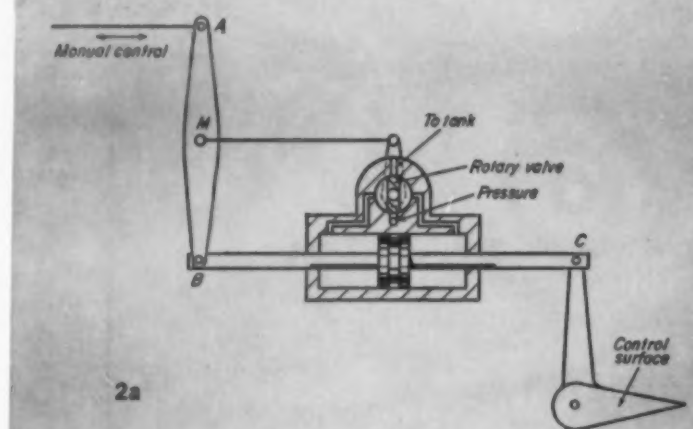


FIG. 1. TWO VIEWS of the rotary servo valve show how it is hydraulically and mechanically centered to prevent binding and keep operating force low. The ports marked U_1 are connected to one end of the actuating cylinder; U_2 ports connect to the other end.



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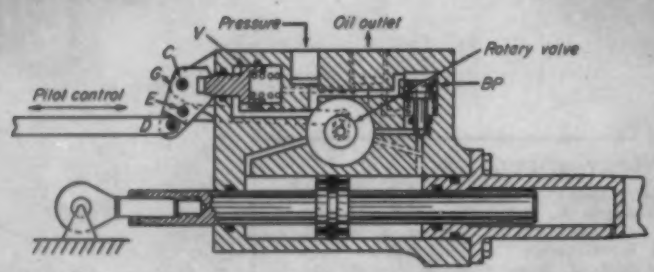

2b

FIG. 2. HYDRAULIC FLIGHT control surface servos using the rotary servo valve.

FIRST servos for flight control surface actuation were built by this company in 1940 for the 80-ton flying boat, the Laté 631. Spool-type servo valves were used in this system with operating pressures of 800 psi. The increase in operating pressures from 800 psi to today's 3000 psi caused lots of problems with spool-type servo valves. Clearances had to be made progressively smaller to prevent high leakage. The smaller clearances resulted in sticking valves. One of the reasons for sticking seemed to be that the high pressure forced the spool against one side of the bore, and squeezed out the oil film, producing high friction. We designed a rotary valve to eliminate these troubles.

• **Rotary Servo Valve**—Both hydraulic and mechanical centering of the movable portion of the valve shown in Figure 1 are used. This results in very low friction torque, about .09 in.-lb. Internal leakage is very low, and the flow vs. rotation characteristics are excellent.

Two servomechanisms using this rotary valve are shown in Figure 2. In the servo of Figure 2a, as the pilot moves the control stick, point *A* moves backward or forward. Since the piston cannot move until the valve is shifted, the lever pivots about point *B*, and point *M* where the lever connects to the valve also moves, and the valve is shifted. Valve movement ports oil to the cylinder and causes the piston to move in a direction to return the lever and the valve to a neutral or off position. Since the cylinder body is fixed, the piston moves in a direction opposite the motion of point *A*. The lever effectively rotates around point *M* as though it were fixed.

The servo actuator in Figure 2b has auxiliary valving to give manual control if hydraulic pressure fails. If pressure is not applied, plunger *V* is forced by spring *R* into a mating slot in lever *G* so the lever cannot rotate about pin *C*. Movement of the control rod by the pilot will then force the whole actuator body to move. Valve *BP* is moved by a spring to connect both sides of the cylinder to tank and prevent hydraulic locking of the actuator.

Applying pressure forces plunger *V* to the right and valve *BP* down. Cylinder chambers are then connected through the rotary valve and lever *G* can pivot around pin *C* to move the valve through pin *E* and a connecting link. Moving the control rod then shifts the valve and applies pressure to move the actuator body and control surface, until the valve is in neutral.

• **Electrohydraulic Systems**—It is desirable to use electrical input to a servo valve for missiles and autopilots. Since available torque motors, 2-phase motors, and d-c motors didn't work too well with the rotary valve, we designed our own torque motor with ± 40-degree rotation. The torque motor is a magnet which rotates in a magnetic field created by the input current, Figure 3. By careful shaping, the torque is proportional to the current and nearly independent of position within the ± 40 degree range. A similar element is mounted on the same shaft and gives an output signal proportional to the speed of rotation of the shaft. This unit is smaller than the torque motor.

A potentiometer, or variable resistance, to measure valve position is connected to the torque motor. Even high-quality resistive potentiometers were too fragile for the angular accelerations of our rotary valve system. Again, we were forced to design our own. We designed an inductive potentiometer, Figure 4, made up of an a-c excited stator in which a rotor coil moves. Output is from the rotor coil. Shaping, again, results in an output voltage which is linear with rotation. Since there is no physical contact between rotor and stator as there is in a conventional potentiometer, there is little friction torque. Actual use has proved the ruggedness of this unit. It is also mounted with and driven by the torque motor. A complete servo actuator with these units is shown in Figure 5.

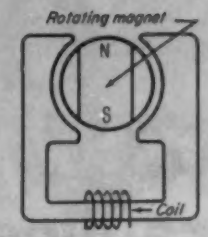

FIG. 3. TORQUE MOTOR for use with the rotary servo valve.

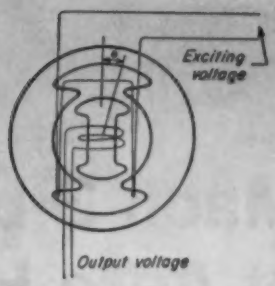

FIG. 4. INDUCTIVE POTENTIOMETER to sense rotary valve position has very low friction and is rugged.

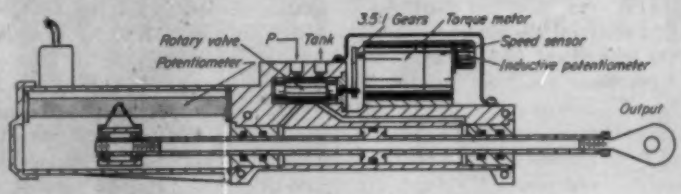

FIG. 5. ELECTROHYDRAULIC SERVO actuator with torque motor, speed sensor, and inductive potentiometer.

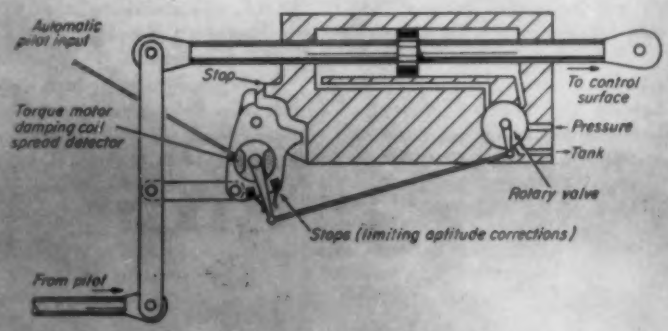

FIG. 6. SERVO ACTUATOR unit with mechanical and electrical inputs. Torque motor, etc., are mounted on a link pivoted on the actuator body. Mechanical input from the pilot moves the entire link assembly. Both mechanical and electrical inputs can be combined, or only one may be used.

• **Automatic Flight Control Applications**—The pure electrohydraulic servo system has many advantages over the mechanical input system. However, pilots don't have the same confidence in wires that they have in mechanical links. A system that gives the pilot positive mechanical control but lets electrical signals from autopilot, trim controls, or stability augmentation devices move the control surfaces at the same time has been developed. This system is shown in Figure 6. Here the torque motor, speed detector-potentiometer assembly are mounted on a link between the control stick and the rotary valve. Motion of the valve by an electrical input is mechanically limited to small values. □□□

Mach 3 by '63 at Aero Hydraulics Conference

WITH the first jet airliners barely off the ground, transports with flight speeds of Mach 3 have been predicted by 1963-1965. W. Bobier, chief engineer, Vickers-Detroit made this prediction at the recent 1958 Aero Hydraulics Conference. Fluid power systems for these aircraft will need vast amounts of power compared to today's planes.

Operating temperatures will exceed 500 F and extreme reliability will be needed because the planes literally won't be able to fly without the hydraulic system functioning.

Beyond the Mach 3 aircraft Bobier predicted that man-carrying orbital vehicles will eventually need hydraulic power for many operations. For these conditions, operating temperatures will probably be between 400 and 750 F. Since 1000 lb of take off weight is required to put one lb into orbit, these sytems will have to be very light and efficient. Reliability obtained by system duplication will be taboo because of weight; components will have to be reliable. Bobier also said that hydraulic pump drives will probably be hot-gas motors operated from rocket engine exhaust at 5000 F, and announced that Vickers has run a developmental unit at this temperature.

Vickers efforts to reduce weight and increase reliability were discussed by R. D. Montgomery, engineering section chief. One approach is operation of pumps at higher speeds. New 11-cylinder designs have let continuous speed ratings be increased to 6200 rpm instead of the 3600 rpm rating for the equipment 9-cylinder pump. Some designs in smaller sizes may soon be operating at 24,000 rpm. Reliability will be improved by contaminant tolerant pumps. One design has run for 40 hours on very dirty test oil with volumetric efficiency falling from 98 to 95.4%.

Almost 150 representatives of airlines, airframe manufacturers, aircraft engine manufacturers, military air services, and other interested parties attended the Conference held at the Park Shelton Hotel in Detroit on November 12. 13 and 14, 1958. Eight nations other than the U. S. were represented. Topics ranged from service difficulties with present equipment to hydraulic needs for aircraft and missiles of the next 20 years. The conference is sponsored by the Aero Hydraulics Div., Vickers Inc.

PAPERS ON AIRCRAFT fluid power systems were given at the 1958 Aero Hydraulics Conference by (standing, left to right) E. Vianney, Sikorsky Aircraft, Lloyd Ludwig, Space Technology Laboratories, (seated, left to right) A. R. Bremer, Boeing Airplane Co., Harlan Asquith, Lockheed Aircraft Corp., and Dwight Moore, Convair.

• **Greater Reliability**—One of the airline people suggested that a new design philosophy was needed to give ultra reliable components for commercial aircraft use. But when asked how much weight could be added to get reliability, the answer was: Only as much as is absolutely necessary. This led to the conclusion that the only way to resolve the weight-reliability problem is by redesign or beefing-up, of components proved to be not reliable enough by actual service experience.

• **Overhaul Kits**—R. Cotton, provisioning supervisor, Vickers, reported on the results of using parts kits instead of individual parts when overhauling hydraulic components. The system has been

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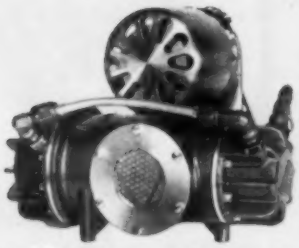

Model 283 two stage Cornelius pressurization pump for service to 60,000 feet without aid of inlet pressurization. Weight: 6.5 lbs. Delivers 200 cu. in. per minute of standard air at 25 psi at 60,000 feet.

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Units are now being delivered for pressurizing water systems on jet liners and for pneumatic de-icer systems on cargo and transport aircraft. The pump's advantages also make it a "candidate" for pressurizing auxiliary fuel systems, as well as electronic or radar wave guide systems and hydraulic reservoir pressurization.

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MODEL 410
Weight 11 ounces
Shown ½ size

Unique jet construction permits passage of particles as large as 200 microns through both the first and second stages without malfunctioning.

Other features include:

Single source of oil in first stage eliminates possibility of unbalance or "hard-over" signals due to oil contamination.

Second stage precisely controlled by a push-pull, frictionless, force feedback servo.

Available with flows from ½ to 50 GPM in four sizes.

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MACH 3

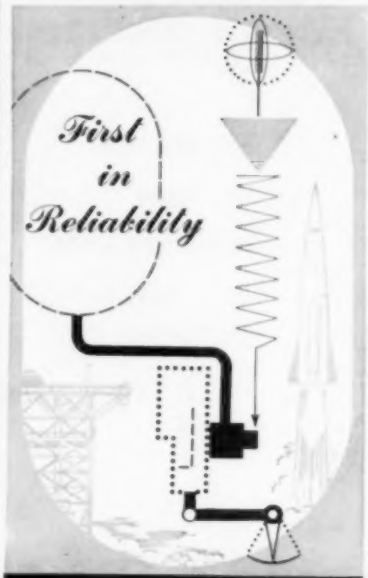
in use for some time now by the Air Force and Navy. Although parts procured in the kits cost more than the individual parts bought for an average overhaul, savings in both time and money come from handling, stocking, and ordering fewer items. Total savings were more than 50% in some instances. Although present kits are designed for military use, some of them could be used in commercial operations, others might have to be redesigned.

• **Convair "880" Hydraulics** —Dwight Moore, assistant design group engineer, Convair, told about the things that were done in designing the "880" hydraulic system to insure reliability. Preventing air entrainment was one objective. To do this they use a nonpressurized tank, a large tank return line, return part of the fluid directly to pump inlet instead of to tank, and divert a very small part of pump output directly back to tank.

Accumulators are used in both pump supply and pressure lines to eliminate pressure surges and pump cavitation when there are sudden changes in system fluid demands. Filters in boost pump supply lines, main pump supply lines and pressure lines keep the fluid clean. All hoses are Teflon. These are felt to offer less possibility of contamination due to liner shredding.

• **Missiles Systems** — Servo valve-actuator units with very little null leakage are needed here for 4000 to 5000 psi operation, according to John W. Kastle, Jr., Missile Systems Div., Raytheon Mfg. Co. Power losses from null leakage create too much heat and can mean the difference between using a one-shot accumulator hydraulic power supply or the larger, heavier, and more costly system with a pump. A good rotary actuator with no end leakage could save much weight and space over the linear types. Mr. Kastle also said that more advanced education in this field and a strong engineering society concentrating on fluid power could probably speed development. □□□

ATCHLEY electro-pneumatic SERVOVALVES



MODEL 610
Weight 11 ounces
Shown ½ size

Unique jet construction permits passage of particles as large as 200 microns through both the first and second stages without malfunctioning.

Other features include:

Single source of gas in first stage eliminates possibility of unbalance or "hard-over" signals due to gas contamination.

Second stage precisely controlled by a push-pull, frictionless, force feedback servo.

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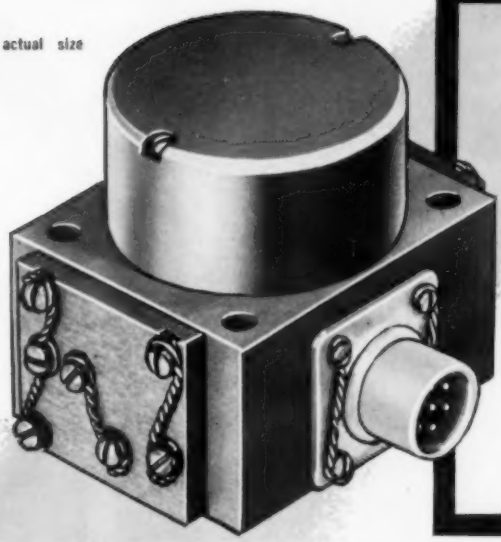
Pesco Servo Valve — actual size

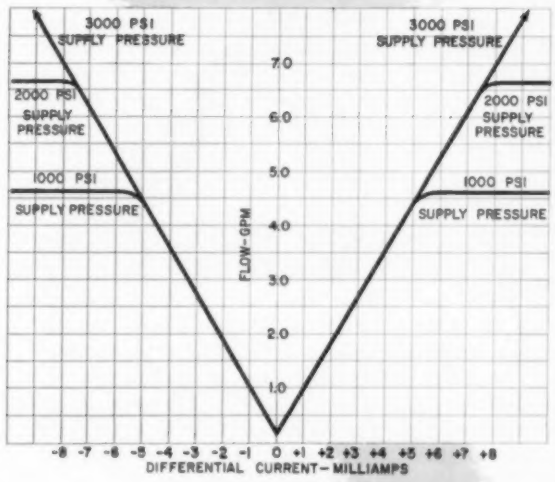


Specifications

Weight: 11 ounces
Flow Range: 0.4 - 7 gpm
Quiescent Flow: 0.1 gpm
Standard Electrical Input: 8 ma
Operating Pressure Range: 500 - 3000 psi
Temperature Range: —65° to 400°F.
Standard Coil Resistance: 1000 ohms

Pesco Servo Valve

achieves performance breakthrough



Performance of Pesco Servo Valve

An advanced high-fidelity servo valve with vitally needed, but previously unavailable, performance characteristics is now available from Pesco. The electro-hydraulic transducer type valve incorporates a unique flow-sensing principle which provides the accuracy, stability and reliability essential in missile and other critical applications.

A flow meter feedback loop of exclusive Pesco design makes the valve virtually insensitive to variations in supply pressure, back pressure, load pressure, temperature and dirt. Other superior performance characteristics include: fast response, low internal friction, minimum null shift, faithful reproduction of smaller input signals, minimum dead zone and threshold, and exceptional linearity.

Valve design is highly producible and flexible enough to meet widely varying application requirements. Miniaturization saves space and weight.

Complete technical data on the new Pesco Servo Valve is contained in Bulletin 5801A, available from your nearest Pesco sales engineer or:

PESCO PRODUCTS DIVISION
BORG-WARNER CORPORATION
24700 North Miles Road • Bedford, Ohio

PESCO . . . means progress in aircraft/missile systems and accessories

CERTIFIED SEALING REPORT NO. 6738

from the Research and Development Laboratories of Plastic and Rubber Products Company, 2100 Hyde Park Boulevard, Los Angeles 47, California. Telephone: AXminster 5-4331

Planes grounded for maintenance represent costly overhead. Only when they are airborne and *overhead* do they pay off by carrying pay loads. That's why the Fuselage Break and Ground Checkout Connectors manufactured by E. B. Wiggins Oil Tool Co., Inc., Los Angeles, California, are so important. This equipment, constructed with high quality parts like Parco O-Rings, eliminates much of the maintenance time and money previously required by physically actuated and disconnected ground checkout apparatus.

Parco O-Rings in Wiggins Socket Assemblies provide positive sealing. When the fuselage is pulled apart, Parco O-Rings help the Wiggins Ground Checkout Connectors to seal off flow of 3000 psi hydraulic fluid *automatically*. Other Parco O-Rings in the Wiggins Connectors and High Pressure Sockets provide positive seals which insure long, trouble-free performance of the Wiggins Ground Checkout equipment.

Trained Parco engineering representatives are always available to help the Design Engineer solve new and critical sealing problems. For high quality Parco O-Rings, custom molded and bonded-to-metal parts just call your nearest Parco representative.

Write today for a free copy of Parco's 16-page, illustrated "Technical Data Reference Log," Catalog #1581.

Plastic and Rubber Products Company
2100 Hyde Park Boulevard
Los Angeles 47, California

Circle **88** *on Time-Saver Card*

AVIATION NEWS

from the fluid power field

JOIN EDITORIAL ADVISORY BOARD

Wm. E. Mahew
Republic Aviation Corp.

John W. Ruttle, Jr.
The Martin Co.

C. F. U. Stoner
Fairchild Aircraft Div.

Three outstanding designers of aircraft fluid power systems have been added to APPLIED HYDRAULICS & PNEUMATICS' Aviation Editorial Advisory Board. They are William E. Mayhew, Republic Aviation Corp., John W. Ruttle, Jr., The Martin Co., and C. F. U. Stoner, Fairchild Aircraft Div.

Together with nine other members of the board, they act as technical consultants to the AH&P editorial staff, and also promote the preparation of articles describing new hydraulic and pneumatic designs.

William Mayhew's engineering experience covers 14 years, after graduation with a BSCE degree from City College of N.Y. Before entering service during World War II, he was employed at Goodyear Aircraft, and Eastern Aircraft Div. of General Motors. Afterward he became chief of the hydraulic and pneumatic systems unit at WADC. He has been in development engineering at Republic for six years supervising hydraulic and pneumatic system designs on the XF-103 and advanced aircraft projects. For the past year and a half, Mr. Mayhew has been project engineer for development of a 1000F hydraulic system, and is now supervisor of Republic's fluid power laboratory. He is a member of SAE's A6B committee and the ASTM D-2 committee.

John Ruttle earned his early aircraft experience in the Aviation Division of Sundstrand Machine Tool Co. where he worked for 5½ years as a research engineer. His academic training was at Drexel Institute of Technology where he received his BSME degree and at Lehigh University where he earned a MSME degree. He is now senior engineer and design specialist in hydraulics for manned aircraft and missiles at Martin.

C. F. U. Stoner brought machine tool design experience with him when he joined Fairchild in 1941. Working first in the experimental engineering department and then in the preliminary design section, he later advanced to group designer for the hydraulic/pneumatic group. In this position he has full responsibility for design and installation of all hydraulic and pneumatic systems.

Walter Kidde & Co., Inc., Aviation Division, Belleville, N. J., announced the opening of a new sales engineering office in San Diego, Calif., **J. L. Reddan** was moved from Kidde's district office in Van Nuys, Calif., to become district manager of the new office.

GREER ACCUMULATORS ...NOW NATION-WIDE SALES AND SERVICE

New!

GREER PRECISION THROTTLING VALVES WITH INTERCHANGEABLE PORT FLANGES

A proven and exclusive valve line available in 6 line sizes up to 2". Greer's universal design concept provides maximum flexibility and standardization for virtually all hydraulic systems. Cuts installation, maintenance, spare parts and other costs.

Write for descriptive Greer Brochure TV-12

THE GREER NETWORK OF SALES OFFICES AND REPRESENTATIVES is now located in cities from coast-to-coast, and is expanded with the addition of a new west coast sales, service and manufacturing facility.

All Greer representatives are specialists in the field of fluid mechanics, and provide know-how and experience in the application of Greer Accumulators and hydraulic components to modern machinery and equipment. Greer distributors and sales offices carry a complete inventory of accumulators and spare parts for prompt, on-the-spot sales and service.

For immediate assistance with any hydraulic problem, your Greer representative is *the man* to contact. Call or write today without obligation.

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Circle **48** *on Time-Saver Card*

AVIATION COMPONENT DATA

Pneumatic Servo Valve . . . features reliability

Model 610, 4-way. First and second stages can pass particles as large as 200 microns. First stage hydraulic pre-amplifier has only one source of gas and can't become

unbalanced due to gas contamination. Second stage is controlled by a high gain, push-pull feedback servo. Maximum output port area, 0.01 sq. in. Operating pressure 1500 psi for temperatures to 250 F.—*Raymond Atchley Inc., Los Angeles, Calif.*

Circle **500** on Time-Saver Card

Miniature Solenoid . . . weighs 8 grams

Designed for applications where low power and linear motion are

required in miniaturization. It delivers a 5-gram pull at .030-in. stroke. Operating voltage is 24 to 30 volts dc. Various mounting brackets and electrical connections are available.—*PSP Engineering Co., Maywood, Calif.*

Circle **501** on Time-Saver Card

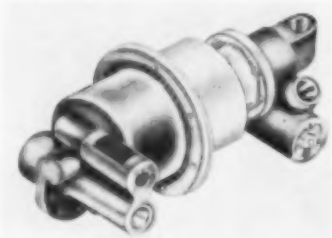
Steel Pneumatic Receiver . . . is lightweight

Comparable in weight to a similar receiver made of titanium. Internal volume 2300 cu. in. Diameter 16.5 in. Weight 27.5 lbs. Working pressure 3150 psi. Burst 6000 psi. Made of alloy steel heat-treated to 260,000 psi tensile strength. Temperature range −65 F to 350 F. Costs about one-fourth that of titanium vessel.—*TAVCO Inc., Santa Monica, Calif.*

Circle **502** on Time-Saver Card

Demand Pumps . . . air or oil-powered

Lightweight reciprocating pumps give demand-responsive flow con-

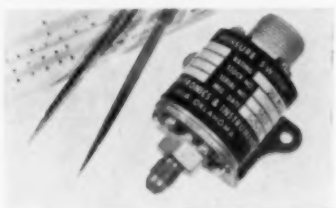


trol and automatic pressure regulation of gases and liquids. Pumps are powered by hydraulic or pneumatic pressure sources and no electric or mechanical drive required. Designed for low flow applications. Input pressure 12 to 275 psi. Output pressure 30 psi. Life 10,000 hours.—*Waldorf Fluid Systems, Waldorf Instrument Co., Huntington Station, N. Y.*

Circle **503** on Time-Saver Card

Absolute Pressure Switch . . . operates at 100,000 ft

Complete unit weighs only 4-¾ oz and has a pressure range of 1 to 30 psia with a proof pressure of 45 psia. Electrical rating is 2.5 amp inductive and 5 amp resistive at 28



v dc. Qualified under MIL-E-5272A-1 and MIL-F-8615. Repeatable accuracy within the −67 to 250 F range is ±5% of original setting. Suited for aircraft and missiles because of its compactness and light weight.—*Century Electronics & Instruments Inc., Tulsa, Okla.*

Circle **504** on Time-Saver Card

Hydraulic Relief Valves . . . with dash-pot to prevent chatter

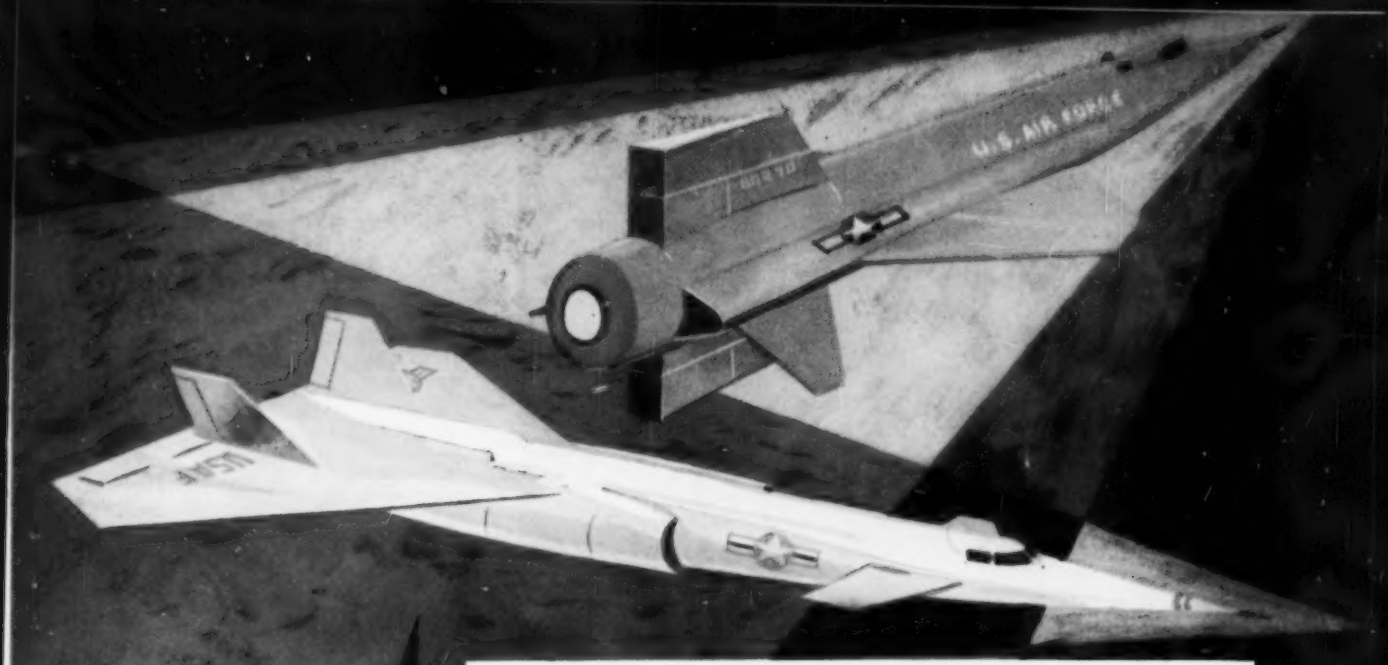
Exceed requirements of MIL-V-8813(ASG) for aircraft and missiles. For ¼, ⅜, and ½-inch tube sizes. Temperature range −65 to 275 F at pressures to 4000 psi. No dynamic O-ring Seals used. An integral, fluid dash-pot prevents noise

and chatter. Internal parts are hardened stainless steel, honed and polished.—*PneuDraulics Inc., Pomona, Calif.*

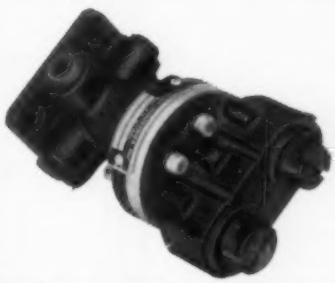
Circle **505** on Time-Saver Card

Continued on page 110

Circle **37** ➡



HIGH-SPEED GEAR PUMPS FOR THE NEXT GENERATION OF AIRCRAFT · MISSILES · SPACECRAFT



High performance hydraulic pumps by Eastern are uniquely suited to the exacting operating requirements demanded in the craft of tomorrow.

Check these Eastern gear pump features — do they suggest a solution to your present design problem?

Small size: Eastern gear pumps are the smallest, lightest made. Airborne servo system pump shown delivers 1.5 gpm @ 1500 psig — measures only 1⅞" X 1⅞" X 2¾", weighs 9 oz.

Wide performance range: pumps available have theoretical displacements from .0016 to .0419 cu. in. per revolution — flow from .025 to 2.0 gpm, pressures from 0 to 2000 psig, at speeds to 24,000 rpm. Weights with motor range from 1.5 to 8.5 lbs.

Unaffected by extreme environments: rugged, reliable Eastern units take loads to 50g in stride — shrug off temperature differentials to meet MIL specs.

Flexibility, economy: mass-produced components can be teamed into the precise configuration you need. Creatively-engineered custom pumps also available.

Contact Eastern for creative contributions to help you solve your hydraulic pump or power problems. Write for Bulletin 360 — your complete new guide to Eastern aviation products.

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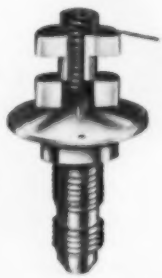
HYDRAULIC POWER • ELECTRONIC COOLING • REFRIGERATION-TYPE COOLING • PRESSURIZATION-DEHYDRATION • SERVO-VALVE HYDRAULIC SYSTEMS •

RMC-LINDSAY ONLY GAUGE TO STAND THIS TEST — This photograph shows vibration testing of RMC-Lindsay pressure gauges on the 3200 force pounds Calidyne Vibrator to 50 G output, amplitude .010 to .20. Cycling frequencies to 2,000 cps. The test is conducted so as to parallel actual installation conditions, with gauges subjected to 350°F under operating pressures. Complete test reports are available on request.

THE RMC-LINDSAY GAUGE IS RADICALLY DIFFERENT

from ordinary high pressure gauges

HERE'S WHY...



1. **The RMC-Lindsay gauge is a multiple coil, helical bourdon tube type, *restricted for overpressure.***
2. **The pointer is attached directly to the end of the coil, with no linkages or pivots to be affected by vibration.**
3. **Superior techniques in coiling, heat treatment, calibration, and material specification *are new and exclusive* with RMC.**
4. **No other gauge can match RMC-Lindsay specifications:**

PRESSURE RANGE: Pressures in ranges 0 to 1,000 p.s.i. up to 15,000 p.s.i. with retard scales available. OVERLOAD PRESSURE: Nominal overload pressure factor of 2.0 times the maximum dial reading (higher factors available). BURST PRESSURE: Normally 3.0 times the maximum dial reading. TEMPERATURE: Not affected by temperatures up to 350°F. VIBRATION: Qualification test report available on pressure tests showing cycling, vibration, to 2,000 cps. at 25 G's, and resonant frequency vibration tests at 25 G's. SHOCK: Data available on MIL-E-5272 shock test. PULSATION: Practically unaffected by line pulsations of 3% of the full dial reading. ENDURANCE: To 250,000 cycles or higher depending on application. ACCURACY: Hysteresis friction and backlash are below readable limits. Absolute gauge accuracy to extremely low limits as required.

Whatever your high pressure gauge problems may be, why not let RMC engineering skill provide the answers. Write, wire or phone either of the addresses below.

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98 Beacon Place, Pasadena, California

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209-C Rockwood Street, Rochester 10, N.Y.

RMC
LINDSAY PRESSURE GAUGES

Circle **119** *on Time-Saver Card*

AVIATION COMPONENT DATA

Relief Valve . . . with external setting

Cracking pressure range is from 10 to 600 psi. Operating temperature range —65 to 350 F. Can be

made special for higher or lower temperatures. For oil, water, or air. Standard size is 1-inch.—*Aero Supply Mfg. Co., Corry, Pa.*

Circle **506** *on Time-Saver Card*

Quick Disconnect Coupling . . . has 22,000-psi burst pressure

Designed for aircraft and missile hydraulic lines, the type 5-5002-8 coupling may be connected and

disconnected with no loss of fluid. Since no balls or dogs are used, there is no brinelling of the retainer seat. Can be connected under high pressure by pushing the two halves together.—*On Mark Couplings Inc., Los Angeles, Calif.*

Circle **507** *on Time-Saver Card*

Electro-Hydraulic Servo Valve . . . weighs under one lb

It's a two-stage electro-hydraulic device which gives an output flow of hydraulic fluid linearly proportional to an electrical input signal in both magnitude and phase. Weighing only 0.85 lb the valve

Continued on page 112

Circle **96** on Time-Saver Card

Let's Shoot The Bull...

ABOUT YOUR LEATHER PACKING PROBLEMS!

At Searle we specialize in solving even the most complex packing problems. May we solve yours?

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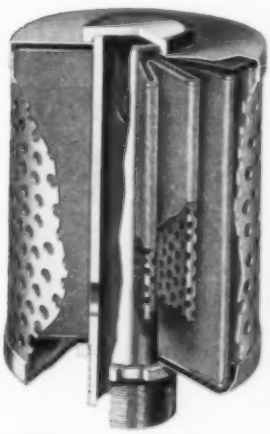
NEW SUMP OIL FILTER

for hydraulic and lube oil systems



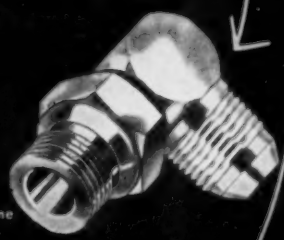
● Screen wire mesh reinforced by pleated perforated metal provides greatly extended filtering area. This results in lower pressure drop, larger dirt capacity. Entire unit protected by perforated cover to prevent accidental damage. A wide choice of bronze, monel, or stainless media provides various degrees of positive filtration. Capacities from 1 to 100 gpm, male or female connection. Write for Specification Sheet OCO-1057. **AIR-MAZE CORPORATION,** Cleveland 28, Ohio. Dept. AH-2.

Circle **4** on Time-Saver Card

You realize more **profits** when using **L & L's** new hydraulic fittings

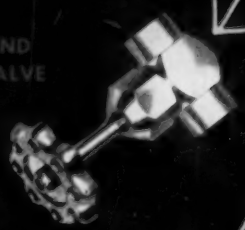
PROFITS

"CN"



- Will stop hydraulic fluid leakage
- Will reduce maintenance . . . assembly time

METERING AND SHUT-OFF VALVE



- Rated for 5000 psi pressures
- Choice of outlets
- Simple maintenance

FLANGE FITTING

- Designed for quick installation
- Eliminates pipe thread connections
- Choice of wide selection of outlets

Other outstanding features:

"CN"

- Eliminates stress in valves, elbows and tees
- Can be positioned 405°
- No need for sealing compounds
- Excellent resistance to vibration
- Hex sizes are small to permit close openings for valves and other component parts

Metering and Shut-off Valve

- Stainless Steel stem
- Adaptable to straight or angle valves with male pipe, female pipe or tube connections
- O-ring only replacement part needed
- Available in sizes—⅛" to ¾"

Flange

- Adaptable to solid and swivel tube, pipe or weld connections
- Can couple together to make unions or clusters

All fittings available in a wide range of shapes, sizes

Write for booklet, "How you Profit with L & L" describing the savings you realize when using L & L fittings.

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Dept. A-2, 8088 E. Nine Mile Rd., Van Dyke, Michigan

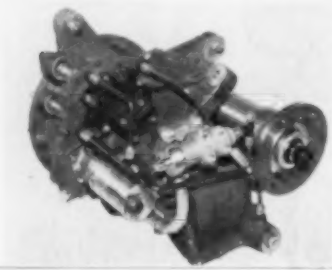
Circle **67** on Time-Saver Card

provides flows from 0.15 to 8 gpm at a normal system pressure of 3000 psi. It will operate at temperatures from −65 to 275 F. Valve is nozzle-flapper design and has a built-in filter.—*Weston Hydraulics, Ltd., North Hollywood, Calif.*

Circle **508** on Time-Saver Card

Constant Speed Drive . . . has high efficiency

Unit combines standard hydraulic pumps and motors with planetary gearing. Electrical Outputs from 20 to 90 kva are available. Efficiencies at designed input speeds are 97%. The planetary gear train is the principal power vehicle, and the hydraulic components differentially add or subtract speed and power as required to maintain constant output speed. Input speed can range from 3800 to 7000 rpm while output is maintained at 6000 rpm.—*Vickers Inc., Detroit, Mich.*



Circle **509** on Time-Saver Card

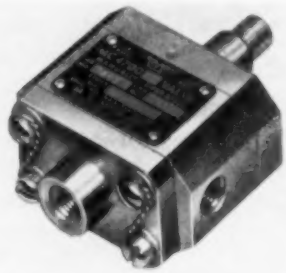
Servo Valve . . . weighs 14 oz

Designed for missiles, the FC-30 flow-control, servo valve has a range of 0.15 to 13 gpm. Internal leakage at 3000 psi is 0.09 gpm. Supply pressure ranges from 500 to 4000 psi. Position of the control valve spool is sensed by a mechanical feedback link which acts on the output of the torque motor. Qualified for use by two major missile manufacturers.—*Cadillac Gage Co., Costa Mesa, Calif.*

Circle **510** on Time-Saver Card

Manual Selector Valve . . . is light and compact

The MC4700 valve is a 4 way, 3-position, manually-operated, selector valve designed to meet MIL-P-5518A and MIL-P-8364A. For air or nitrogen to 350 psi from −65 to 275 F. Port connections are for 3/16-in. tubing. Weight 0.44 lbs.—*M. C. Manufacturing Co., Lake Orion, Mich.*



Circle **511** on Time-Saver Card

Capital

HYDRAULIC FILTERS

for Hydraulic and Oil Re-circulating Machinery

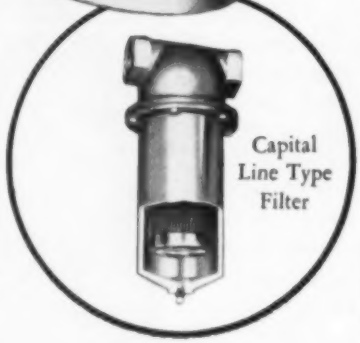
Capital Hydraulic Filter Units are smaller than ordinary filters but with filtering capacity equal or superior to many larger filters. Small size permits greater latitude in design, particularly where space is restricted.

Capital Filter Units are designed with one-piece construction — no screws or nuts to work loose and be lost or mislaid. Simple and easy to clean by any method.

Made from specially designed woven Monel wire, with narrow corrugations presenting the greatest filtering area. Monel support supplies extra sturdiness.

Capital Filter Units are made in 4 Types:

- **MONO-BILT 60 Mesh All Stainless Steel (Sump type).**
- **MONO-BILT Standard All Stainless Steel**
- **MONO-ECONO Mono-Bilt with Monel Metal Insert and Cadmium Plated Top and Bottom.**
- **LINE TYPE with Aluminum Housing and Mono-Bilt, one Piece Filter Unit.**



Capital Line Type Filter

Built from Monel Metal they are impervious to rust and corrosion.

CAPITAL ENGINEERING & MFG. CORP.

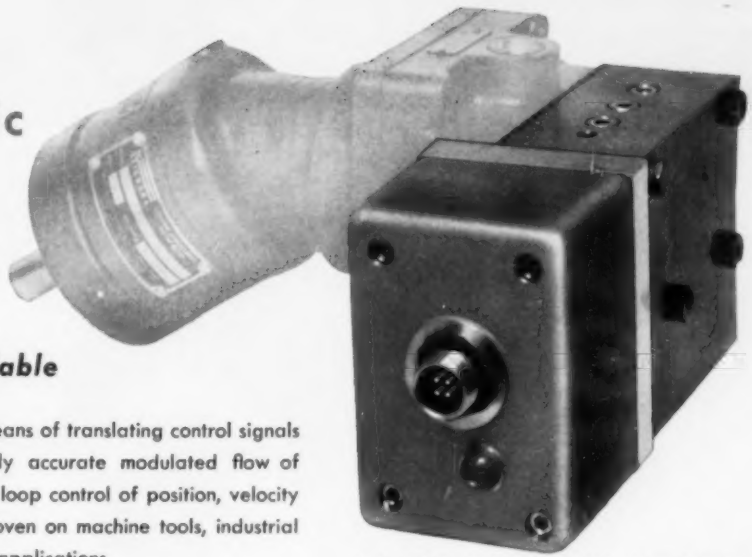
5836 SOUTH ASHLAND AVENUE, CHICAGO 36, ILLINOIS

Circle **21** on Time-Saver Card

New VICKERS® Electro-Hydraulic Servo Valve

has numerous advantages for industrial use:

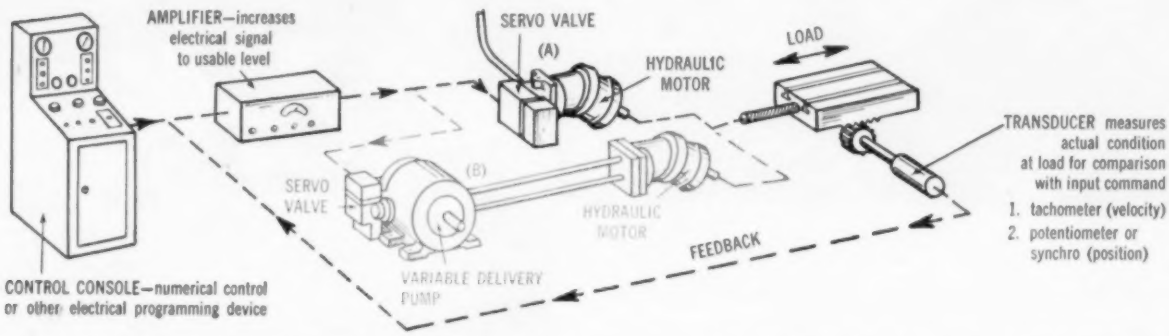
- ***Extremely Accurate***
- ***Simple • Rugged • Dependable***



Vickers Electro-Hydraulic Servo Valve integrated with piston type hydraulic motor provides a minimum amount of oil under compression. Integral cross line relief valves are provided as well as variable cross line orifice for controlling viscous damping. This "package" can provide approximately 20 hp @ 3000 psi and 3600 rpm; variable speed of motor is 0-4400 rpm.

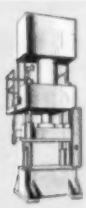
This valve provides a simple, dependable means of translating control signals from electronic programming into extremely accurate modulated flow of hydraulic power for fast and precise closed loop control of position, velocity and acceleration. Performance has been proven on machine tools, industrial processing equipment and ground ordnance applications.

Simplicity and reliability are exceptional . . . only four moving parts are required. Mechanical feedback linkage with unique variable fulcrum provides optimum flexibility for various conditions of flow, response and pressure. For further information, write for Vickers Engineering Bulletin 58-74.

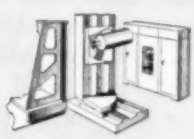


Now the flexibility of electronic control can easily be applied to versatile hydraulic power. Vickers new industrial electro-hydraulic servo valve is used (A) to directly regulate the oil to an actuator (valve motor system). Shown in blue is an alternate application (B) for higher flows when the valve controls a variable volume pump (servo pump system).

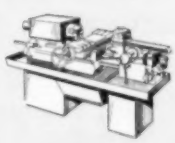
REPRESENTATIVE SERVO VALVE APPLICATIONS



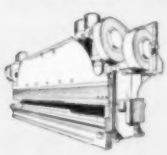
PRESS
Ram velocity controlled accurately during all cycles.



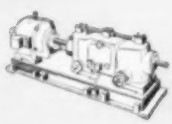
MILLING MACHINE
Precision control of velocity, position and acceleration of slides and tables.



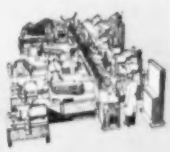
LATHE
Exact feed rate and position control of cutting tool.



PRESS BRAKE
Cylinders synchronized precisely.



VARIABLE SPEED DRIVE
Accurate velocity control of spindle speeds for test stands or machine tools.



PROCESS LINE
Programmed control of Material Handling and machine sequencing.

8126

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
Machinery Hydraulics Division
ADMINISTRATIVE and ENGINEERING CENTER
Department 1474 • Detroit 32, Michigan

Application Engineering Offices: ATLANTA • CHICAGO • CINCINNATI • CLEVELAND • DETROIT • GRAND RAPIDS • HOUSTON • INDIANAPOLIS • LOS ANGELES AREA (El Segundo) • MILWAUKEE • MINNEAPOLIS • NEW YORK AREA (Springfield, N.J.) • PHILADELPHIA AREA (Media) • PITTSBURGH AREA (Mt. Lebanon) • PORTLAND, ORE. • ROCHESTER • ROCKFORD • SAN FRANCISCO AREA (Berkeley) • SEATTLE • ST. LOUIS • TULSA • WORCESTER • Factories also in: AUSTRALIA, ENGLAND, JAPAN AND GERMANY • In Canada: Vickers-Sperry of Canada, Ltd., Toronto, Montreal and Vancouver

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

Circle **110** *on Time-Saver Card*

MORE ABOUT THE GARLOCK 2,000

JUST SNAP YOUR FINGERS... GARLOCK HAS THE RIGHT HYDRAULIC LEATHER PACKINGS... FOR YOU

All shapes, all sizes, all materials and designs of hydraulic packings are available to you from Garlock. Garlock BITAN* Leathers, for example, are made in all types in a modern leather packing plant which maintains highest standards of quality. Molded Cups, "U" Packings, "V" Packings, Washers, Gaskets, Discs, Flange or Hat Packings are some of the more commonly specified types. Sizes range from 1/8" O.D. leather washers for needle valves to 99" O.D. "U" Packings for heavy duty hydraulic service.

Let us know your requirements. Your Garlock representative will recommend from "the famous Garlock 2,000" . . . two thousand styles of packings, gaskets, and seals for every need. The only *complete* line. Call today or write for leather packing Folder AD-121.

*Registered Trademark

THE GARLOCK PACKING COMPANY, Palmyra, New York

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints, Fluorocarbon Products

Circle **44** on Time-Saver Card

USE ONE OF THESE

USE ONE OF THESE TIME-SAVER CARDS...

...for more information on advertised products, new components, useful literature, etc. Just circle item number and drop in the mail.

New Products

Descriptions start on page 46

CHECK VALVE 300
Fluid Regulators Corp.

SERVOCONTROL POWER AMPLIFIER 301
The Oilgear Co.

AIR REGULATOR 302
Wilkerson Corp

FILTER ELEMENTS 303
Bendix Filter Div.

SEAL COMPOUND 304
The Garlock Packing Co.

AIR & HYDRAULIC CYLINDERS 305
S-P Mfg. Co.

DIRECTIONAL VALVES 306
Parker-Hannifin Corp.

AFTERCOOLER 307
Ross Heat Exchanger Div.

CONTROL VALVES 308
Hunt Valve Co.

HYDRAULIC PUMPS 309
Vickers Inc.

ABSOLUTE PRESSURE TRANSMITTER 310
Automatic Timing & Controls Inc.

ROTARY CONTROL VALVES 311
Clark Engr. & Mfg. Co.

AIR LINE REGULATOR 312
Watts Regulator Co.

FLUID MOTORS 313
Hydreco Div., New York Air Brake Co.

PILOT OPERATED RELIEF VALVES 314
Republic Mfg. Co.

CONTROL VALVES 315
Valvair Corp.

LIMIT SWITCHES 316
R. B. Denison Mfg. Co.

PRESSURE REDUCING VALVE 317
Atlas Valve Co.

FLOW CONTROL VALVES 318
Auto-Ponents Inc.

FLEXIBLE COUPLING 319
Sier-Bath Gear & Pump Co.

IN-LINE SOLENOID VALVE 320
Valcor Engineering Corp.

TORQUE MOTOR 321
American Measurement & Control Inc.

OIL LINE FILTER 322
Schrader Brothers Corp.

Useful Literature

Descriptions start on page 58

CONTROLABLE CHECK VALVE 400
Fluid Regulators Corp.

AIR FILTERS 401
Commercial Filters Corp.

SERVOCONTROL 402
The Oil Gear Co.

SWING JOINTS 403
Jordan Corp.

FEBRUARY, 1959 — Circle number to receive free information about any product described or advertised in this issue.

ADVERTISERS

1	21	41	61	81	101	121	141	161	181	201	221
2	22	42	62	82	102	122	142	162	182	202	222
3	23	43	63	83	103	123	143	163	183	203	223
4	24	44	64	84	104	124	144	164	184	204	224
5	25	45	65	85	105	125	145	165	185	205	225
6	26	46	66	86	106	126	146	166	186	206	226
7	27	47	67	87	107	127	147	167	187	207	227
8	28	48	68	88	108	128	148	168	188	208	228
9	29	49	69	89	109	129	149	169	189	209	229
10	30	50	70	90	110	130	150	170	190	210	230
11	31	51	71	91	111	131	151	171	191	211	231
12	32	52	72	92	112	132	152	172	192	212	232
13	33	53	73	93	113	133	153	173	193	213	233
14	34	54	74	94	114	134	154	174	194	214	234
15	35	55	75	95	115	135	155	175	195	215	235
16	36	56	76	96	116	136	156	176	196	216	236
17	37	57	77	97	117	137	157	177	197	217	237
18	38	58	78	98	118	138	158	178	198	218	238
19	39	59	79	99	119	139	159	179	199	219	239
20	40	60	80	100	120	140	160	180	200	220	240

NAME .....

POSITION: .....

COMPANY: .....

PRODUCT MFG.: .....

STREET .....

CITY ..... ZONE ..... STATE .....

Do not use after 5-15-59

NEW PRODUCTS

300	305	310	315	320	325	330	335
301	306	311	316	321	326	331	336
302	307	312	317	322	327	332	337
303	308	313	318	323	328	333	338
304	309	314	319	324	329	334	339

FREE LITERATURE

400	405	410	415	420	425	430	435
401	406	411	416	421	426	431	436
402	407	412	417	422	427	432	437
403	408	413	418	423	428	433	438
404	409	414	419	424	429	434	439

AVIATION DATA

500	505	510	515	520	525	530	535
501	506	511	516	521	526	531	536
502	507	512	517	522	527	532	537
503	508	513	518	523	528	533	538
504	509	514	519	524	529	534	539

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12	32	52	72	92	112	132	152	172	192	212	232
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14	34	54	74	94	114	134	154	174	194	214	234
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504	509	514	519	524	529	534	539

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Flodar Corp.

VALVES & FITTINGS 405
Henry Vogt Machine Co.

LIQUID SEALANT 406
American Sealants Co.

SOLENOID VALVES 407
Waterman Engineering Co.

HYDRAULIC PISTON PUMPS 408
Dynex, Inc.

FIRE RESISTANT FLUIDS 409
D. A. Stewart Oil Co.

HYDRAULIC POWER UNITS 410
John S. Barnes Corp.

FORGED STEEL FITTINGS 411
H. K. Porter Co.

SNAP-ACTION SWITCHES 412
Micro Switch Div.

DIAL THERMOMETERS 413
United States Gage

CONTROL VALVES 414
Beckett-Harcum Co.

TUBULAR PRODUCTS 415
The Babcock & Wilcox Co.

GASKET MATERIAL 416
General Gasket, Inc.

PRESSURE GAGES 417
Helicoid Gage Div.

TEFLON HOSE 418
Titeflex Inc.

AIR CYLINDERS 419
Modernair Corp.

Aviation Component Data

Descriptions start on page 108

PNEUMATIC SERVO VALVE 500
Raymond Atchley Inc.

MINIATURE SOLENOID 501
PSP Engineering Co.

STEEL PNEUMATIC RECEIVER 502
TAYCO Inc.

DEMAND PUMPS 503
Waldorf Instrument Co.

ABSOLUTE PRESSURE SWITCH 504
Century Electronics & Instruments Inc.

HYDRAULIC RELIEF VALVES 505
PneuDraulics Inc.

RELIEF VALVE 506
Aero Supply Mfg. Co.

QUICK DISCONNECT COUPLING 507
On Mark Couplings Inc.

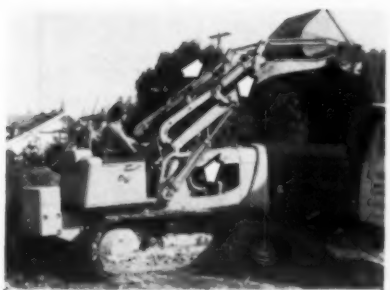
ELECTRO-HYDRAULIC SERVO VALVE 508
Weston Hydraulics, Ltd.

CONSTANT SPEED DRIVE 509
Vickers, Inc.

SERVO VALVE 510
Cadillac Gage Co.

MANUAL SELECTOR VALVE 511
M. C. Manufacturing Co.

with ROCKRITE® Cylinder Finish Tubing!



The J. I. Case Company tractor line uses ROCKRITE tubing as standard for all external hydraulic cylinders. "Terra Trac" crawler-loader (above) operates bucket through cylinders of stock ROCKRITE 5½" O.D. x 5" I.D. and 4½" O.D. x 4" I.D., used as supplied.

Leading manufacturers find ROCKRITE Tubing cuts fabrication of hydraulic cylinders—here's why! An extremely high surface finish, *plus* an extremely high dimensional tolerance permit the use of ROCKRITE Tubing "as supplied." You merely cut to required length and use without further machining inside or out—finished unit costs are often cut by as much as 50%!

ROCKRITE also increases cylinder packing life. A fine, mirror-like surface results from the ROCKRITE method of cold forging and rolling—boring and honing are eliminated. Also, the ROCKRITE method avoids longitudinal scratches or burrs.

Investigate the cost-cutting advantages you can gain with ROCKRITE Tubing—write for technical bulletin R-10 today.

ROCKRITE Tubing is available in low carbon grades at all leading Steel Service Centers. Available also, to your exact specifications, in a wide variety of analyses, sizes, lengths and mechanical properties. Tube Reducing engineers welcome the opportunity to discuss your requirements.

The ROCKRITE method is gaining wide use for *Special Products*—when perfection in dimension and quality is required for helicopter rotary wing sections, rocket and missile sections and contour bore tube.

Rare Metals—to eliminate waste of expensive metals and assure accurate, defect-free tubing from Columbium, Titanium, Uranium, Zirconium, etc.

ROCKRITE® TUBING

TUBE REDUCING CORPORATION

A SUBSIDIARY OF AMERICAN METAL PRODUCTS COMPANY

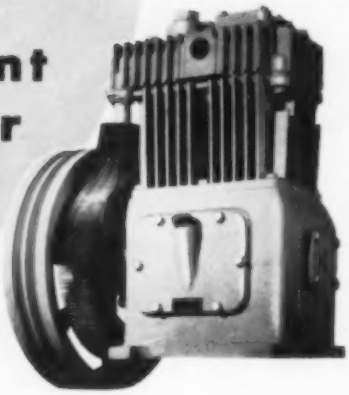
6-382

520 MAIN AVENUE, WALLINGTON, N. J. • MAILING ADDRESS: P.O. BOX 959A, PASSAIC, N. J.

Circle **120** *on Time-Saver Card*

AIR POWER

as efficient as your design



Quincy COMPRESSORS

With Safe-Q-Lube and Loadless Starting

Here is *versatile* efficiency.

When you specify a Quincy compressor, you select from 21 different models in a capacity range of from 1 to 90 CFM.

And Quincy gives you *long-term* efficiency. The exclusive Safe-Q-Lube system unloads the compressor in event of low oil pressure. Loadless Starting gets the unit off to smooth, easy starts.

Thus, maintenance costs and time are cut to a minimum . . . and the entire machine you design benefits from these Quincy advantages. Specify Quincy performance and durability when your plans call for an air compressor.

Industrial Models 1 to 90 CFM

Quincy COMPRESSORS

QUINCY COMPRESSOR CO.,
Dept. AH-259, Quincy, Illinois

Gentlemen:

I'd like to know more about Quincy compressor design advantages. Please send free catalog of industrial models.

NAME

FIRM

ADDRESS

CITY ZONE STATE

Circle **89** on Time-Saver Card

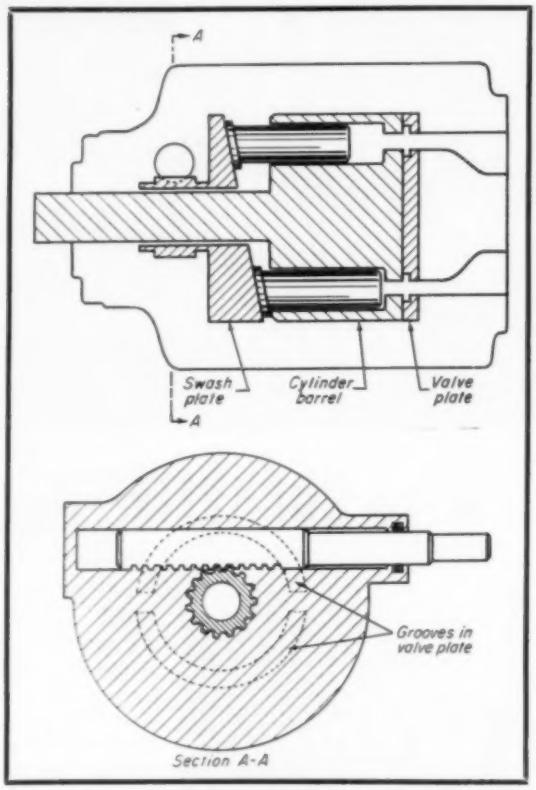
FLUID POWER PATENTS

VARIABLE VOLUME PUMP

U. S. Patent 2,847,938, John T. Gondek, Minneapolis, Minn.

An axial-piston pump in which the swash-plate angle is constant. Displacement is varied by rotating the swash-plate relative to the valve plate.

Cylinder barrel rotates with the drive shaft, and fluid is pumped from each successive cylinder into one of two grooves in the valve plate. With the swash-plate in the position shown, each piston will pump



during one-quarter of a revolution into one groove and during the following quarter revolution into the other groove. Similarly each piston will draw fluid from one groove during one-quarter revolution and then draw fluid from the other groove during the next quarter revolution. Fluid will circulate but none will be discharged.

If the swash plate is rotated 90 degrees in one direction, the full stroke of each piston will draw fluid from one groove during ½ revolution, and discharge into the other groove during the remaining ½ revolution. If the swash plate is rotated 90 degrees in the other direction the suction and discharge ports are reversed. □□□

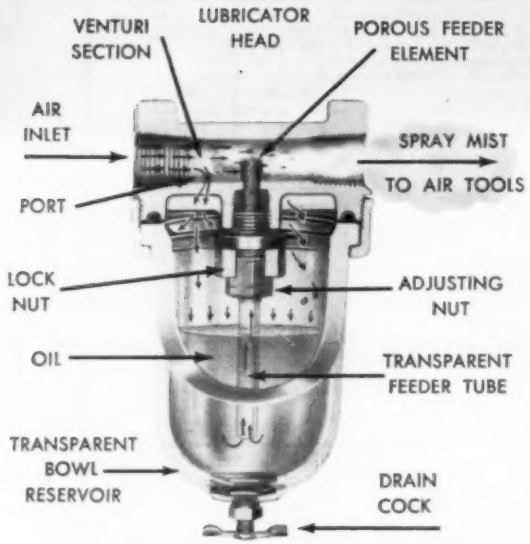
Continued on page 120

Circle **11**

Arrow AIRLINE SPRAY MIST LUBRICATORS

Supply a fine Spray Mist Lubricant by the most efficient and effective two-stage method!

By PRE-DIVIDING or breaking up the oil in the first stage before completely atomizing the Lubricant in the second stage. The Spray Mist is then carried along throughout the entire pattern of the air stream to lubricate the working parts of air-powered tools, cylinders, valves and other pneumatic devices.



Illustrates the operation of the ARROW "patented" two-stage, tamper- proof Lubricator.

Compressed air from the drop line enters the Lubricator to Venturi section of the Lubricator Head where the porous feeder element protrudes into the Air Stream.

Small ports in front of the porous feeder permits air pressure transfer on the oil surface in the bowl reservoir. The pressure differential created by the Venturi forces the oil to rise in the transparent feeder tube, into and through the porous feeder element which PRE-DIVIDES the Lubricant in this first stage, into minute particles of oil.

The Lubricant now finely divided and saturating the porous feeder element, is now easily and most efficiently atomized from the feeder element, at this second stage, by the action of the Venturi on the compressed air passing through the Lubricator Head.

The two-stage method incorporated in the ARROW LUBRICATOR insures a fine spray mist for wider ranges of AIR FLOWS at lower pressure drops.

Simplicity of design with only one tamper-proof adjustment provides for most efficient, low-cost operation.

PROTECT YOUR PNEUMATIC EQUIPMENT

Complete Conditioning and Control of Compressed Air Prolongs Service Life, Reduces Maintenance and Repair of Air-Powered Tools, Cylinders, Valves and Other Pneumatic Equipment.

the most Efficient and Complete AUTOPNEUMATIC CONTROL By Arrow

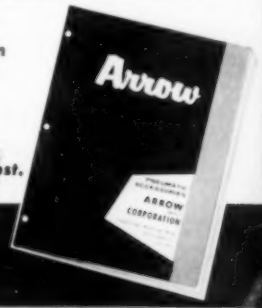
A choice of fine or coarse grade porous Bronze Feeder Wick as required for lubricant or application. A choice of Hand Filling Type Lubricator or a Pressure Filling Type with Button Head Fitting or the ARROW . . . New Fully Automatic Filling Type which with the Automatic Drain Trap makes Autopneumatic Control completely automatic, eliminating all hand or manual servicing.

Many Types and Models of Single Units and Units in Combination Assemblies to Meet Specific Requirements.

PIPE LINE SIZES—

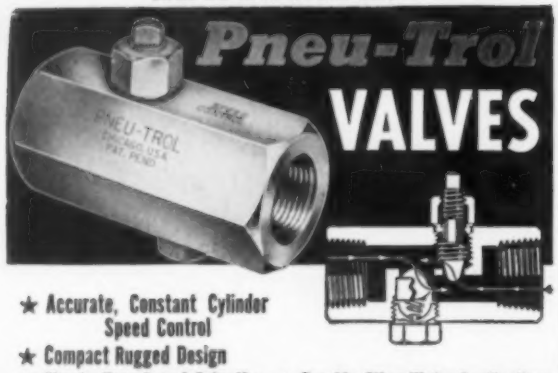
¼"—⅜"—½"—¾" and 1" N.P.T.

Catalog and Engineering Data Sent on Request.

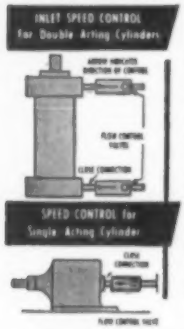


ARROW TOOLS, INC. 1934 S. KOSTNER AVE. CHICAGO 23, ILL.

Circle **13** on Time-Saver Card



★ Accurate, Constant Cylinder Speed Control
★ Compact Rugged Design
★ Simple, Easy Speed Selection ★ For Air, Oil or Water Applications



Pneu-Trol Speed Control Valves, are widely used in hundreds of control applications because they combine in a short, compact body, a tapered fine thread needle for extremely accurate air or oil flow control and a floating retro ball check, which permits full flow in the opposite direction. Retro ball floats in most sensitive position to its seat, requiring only a slight differential pressure to fully open or close it.

Needle design permits maximum flow capacity in the controlled direction. Metal to metal needle and ball seats insure long trouble-free service. Simple, practical "O" gland structure eliminates troublesome leaking. Valve bodies machined from hex brass or aluminum for 2000 psi working pressures; steel and stainless steel for 5000 psi. Made in 5 female pipe sizes—⅛" to ¾". ATTRACTIVE PRICES . . . IMMEDIATE DELIVERY.

Write for illustrated circular and prices.

AUTO-PONENTS,® INC.

Manufacturer of Pneu-Trol Valves
2919 GRANT STREET • BELLWOOD (Chicago Suburb) ILLINOIS

THE COMPLETE PACKING UNIT
for Hydraulic or Pneumatic rods and cylinders

MON-O-PAK® CARTRIDGE

- Easily and quickly installed.
- No adjusting necessary.
- Equipped with Anti-Backlash rings.
- Includes Seal-Guard® rod wiper.
- Low friction coefficient.
- Shock and burst proof.
- Reduces initial machining cost.
- Gives longer service life.
- Cuts machine down-time.
- Easily removed for replacement.

Write for catalog and prices.

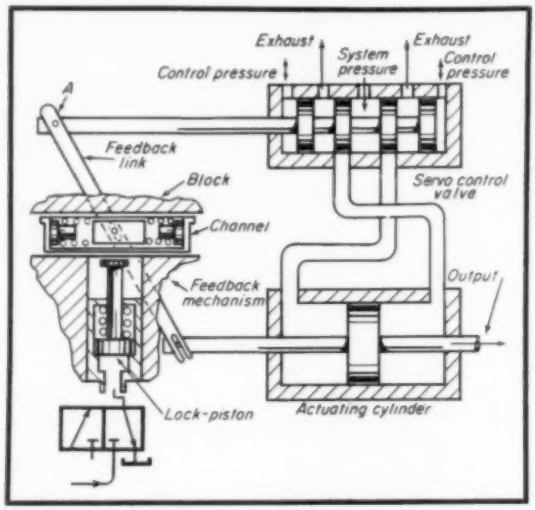
HYDRAULIC ACCESSORIES CO.
24301 Hoover Road, Warren Mich.

MECHANICAL FEEDBACK CONTROL

U. S. Patent 2,846,982, Dean L. Huppert & Harold P. Sorenzen, assigned to Minneapolis-Honeywell Regulator Co.

An arrangement to cut feedback in or out and give a calibrated delay in transmitting feedback when first engaged.

Servo control valve is shown in neutral or closed position. Area beneath the lock-piston in the feedback mechanism is open to drain. This allows the channel and block assembly to slide freely. Movement of actuator piston will not move control valve



spool but will cause lateral movement of channel and block with feedback link pivoting about point *A*. If the control valve spool is moved (by varying the control pressure at either end), the actuator cylinder will complete its entire stroke with no feedback transmitted to the control valve.

When it is necessary to control position of the actuator cylinder, the 3-way valve is shifted, and fluid presure forces the lock-piston up, locking the channel at that point.

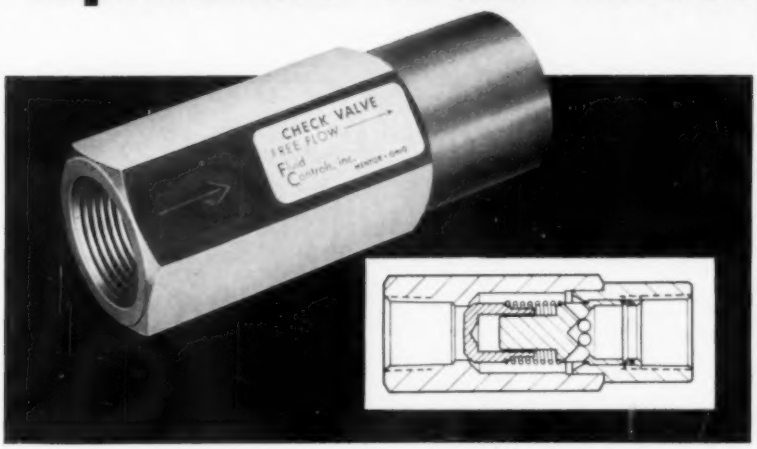
If the control valve is now moved from neutral, causing movement of actuator piston, the feedback link will move the block against spring pressure to a positive stop. Further movement of actuator piston rotates feedback link around the pin in the block and returns control valve spool to neutral. Cylinder is locked against further movement in the same direction. □□□

Plan now to enter the
1959 Fluid Power Prize Paper Contest
$1400 in Cash Awards
For a Rules Booklet
Circle 240 on Time Saver Card

Circle **58** on Time-Saver Card

Circle **41** on Time-Saver Card

Dependable Check Valves



- Can't Stick Open
- Low Pressure Drop
- For Oil
- Copper Brazed Steel Bodies
- To 5000 P.S.I. Service
- Pipe Sizes ¼" thru 1¼"

Write for detailed specifications and prices.

Fluid Controls, inc.

Manufacturers of Hydraulic Valves and Devices

Relief Valves • Check Valves • Restrictor Valves
Needle Valves • Pilot Check Valves • Special Valves
Pressure Compensated Flow Regulators

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Longer, trouble-free service or your money back! Your opinion is final.

Write for literature and service data sheets, or send prints and condition of operation for recommendations and quotations.

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BUSHINGS
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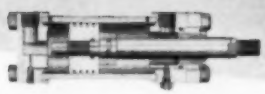
THE American Crucible PRODUCTS CO.

1303 Oberlin Avenue — Lorain, Ohio, U. S. A.

Circle **7** on Time-Saver Card

sealed right!



O-M Heavy-Duty Series TH
Hydraulic (Oil) Cylinders

IF you are experiencing difficulty with leakage through the seals and packings of the cylinders you have been using, the O-M "TH" Series Heavy Duty Hydraulic cylinders may be the answer to your problem. Since their introduction in 1955 these cylinders have established an enviable reputation for efficient and trouble-free service.

The O-M Series TH Cylinders are Designed Right to Seal Right. Prior to the design of these cylinders, many tests were made and field experiences were surveyed to find the most efficient way to eliminate the old "leakage problem".

Homogeneous "O" rings, with their elastic characteristics, cannot be excelled as static seals when backed-up with plasticized leather non-extrusion rings and installed in a properly designed cavity.

Ring-type piston packings are excellent for long-life and trouble-free performance when a small amount of piston by-pass is permissible. When by-pass is not allowable, "Vee-type" packings similar to those used as standard in the rod gland provide optimum sealing. The "Vee-type" packing is self adjusting and provides multiple lip sealing with excellent pressure sensitivity and long life.

The homogeneous "lip-type" rod wiper or the metallic scraper (your choice) is located well forward so as to prevent dirt from accumulating and scoring the piston rod and damaging the bearing and packing.

O-M Series TH Cylinders are "Designed Right" and "Sealed Right". Available in 1½" to 8" bores with complete selection of mountings. Mail coupon TODAY for Bulletin No. 105 showing description drawings of cylinders mountings and capacity chart.

ORTMAN-MILLER MACHINE CO.
1 143rd Street, Hammond, Ind.

☐ Have representative call
☐ Send Bulletin 105

Name _____ Position _____
Company _____
Address _____
City _____ Zone ____ State _____

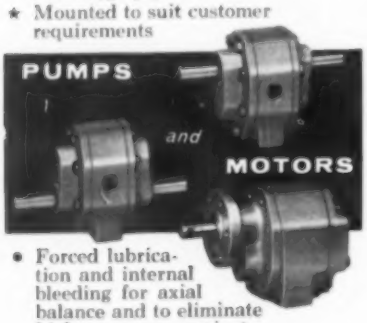
Circle **80** on Time-Saver Card

Precision Engineered Hydraulic Equipment

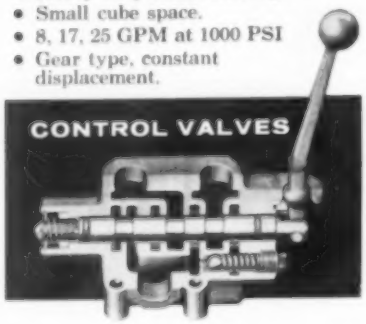
. . . by the World's Largest Builders of Hydraulic Jacks . . .

NEW, LOW COST MANUAL HYDRAULIC PUMP FOR AGRICULTURAL OR LIGHT INDUSTRIAL EQUIPMENT

- ★ Stroke 2⅜"
- ★ Maximum Operating Pressure 1500 PSI
- ★ Fluid Capacity .966 gallon with tank ⅔ full
- ★ Weight 22 lbs.
- ★ Overall Height 21"
- ★ Handle Length 20" overall. 17½" pipe handle
- ★ Mounted to suit customer requirements



- Forced lubrication and internal bleeding for axial balance and to eliminate high pressures against oil seals.
- Rotate in either direction.
- Heavy-duty roller bearings.
- Small cube space.
- 8, 17, 25 GPM at 1000 PSI
- Gear type, constant displacement.



- Large oil passages.
- Close grained, high tensile alloy body castings.
- 2 types of action.
- Spring centered, ball detent hold.
- Hardened ground spool.
- Precision honed valve body.
- Pressure relief valve.
- Hardened seat insert for long life.

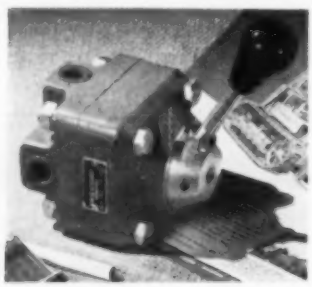
Hein-Werner Corporation
Waukesha, Wisconsin

HEIN-WERNER CORPORATION
WAUKESHA 4, WISCONSIN
Circle **52** *on Time-Saver Card*

NEW PRODUCTS

ROTARY CONTROL VALVES
. . . have low handle torque

Features: Use lapped seals to eliminate internal leakage. Rotor rides on roller bearings for easy handle operation. Good metering characteristics. For lift trucks road machinery and machine tools.
Specifications: Capacities 2½ to 14 gpm and pressures to 3000 psi. Made in 2, 3, and 4-way types, open or closed center, detent positioned or spring centered. Removing four bolts separates housing from body. Replacing rotor, seals and bearings puts valve in new condition.



Clark Engr. & Mfg. Co.
Racine, Wis.
Circle **311** *on Time-Saver Card*

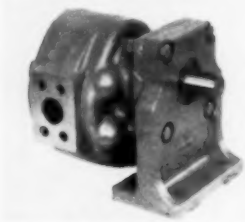
AIR LINE REGULATOR
. . . is compact

Designation: Series 112
Features: High flow capacity and accuracy. Low cost. Die cast zinc body with brass internal parts. Buna-N diaphragm and disc. Made in ¼-inch NPT with or without self-relieving feature. The self-relieving allows pressure adjustment without venting the line.

Watts Regulator Co.
Lawrence, Mass.
Circle **312** *on Time-Saver Card*

FLUID MOTORS
. . . have flanged ports

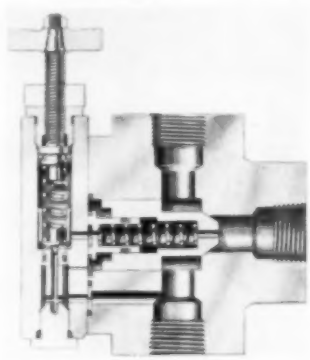
Designation: 4MO Series
Features: Rated from 90 to 210 pounds-inch torque per 100 psi. Operating pressure 1000 psi. Made in both flange and foot mounting. Ports for SAE split-flange connections. Cast body with heat-treated gears.



Hydreco Div.
New York Air Brake Co.
Kalamazoo, Mich.
Circle **313** *on Time-Saver Card*

PILOT-OPERATED RELIEF VALVES
. . . for 5000 psi

Designation: Model 650
Features: Low pressure differential across main piston gives accurate control. Holds system pressure constant with varying flows. Can be modified for use as a sequence or unloading valve.
Specifications: Pressure ranges 50 to 1200 psi, 1000 to 3000 psi, and 2500 to 5000 psi. Bodies standard 30,000 lb tensile steel with bosses for panel mounting. Also made in aluminum. Port sizes ¼ to 1¼ NPT or straight threads.

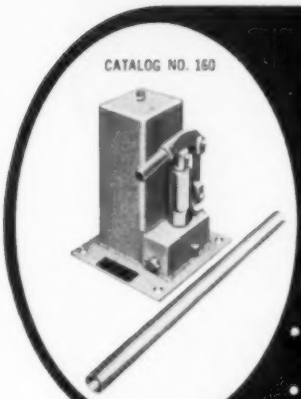


Republic Mfg. Co.
Cleveland, Ohio
Circle **314** *on Time-Saver Card*

CONTROL VALVES
. . . are remote operated

Features: For use in hazardous locations or wherever remote pilot operation is desired on any pneu-

Circle **87** on Time-Saver Card



Hand Hydraulic Pumps

- Single and Double Designs to 20,000 psi
- With or Without Reservoir

160 cubic inch reservoir with 8"x 8" base plate and 18" long handle.

Available with optional size pistons ⅜", ½", ¾", 1" and 1½".

We specialize in the manufacture of hand pump units which operate in temperatures from −65° F. to +160° F. and with any capacity reservoirs required. Pumps can be furnished on special order with custom seals to handle various aircraft types of fuels such as Pydraul, Skydrol, Oronite, etc.

The single pump with ½", ¾", 1" or 1½" piston is now available in stainless steel.

for additional information write:

WILLIAM S. PINE

hydraulic hand pumps for 1001 uses

1635 East 22nd St., Los Angeles 11, Calif.

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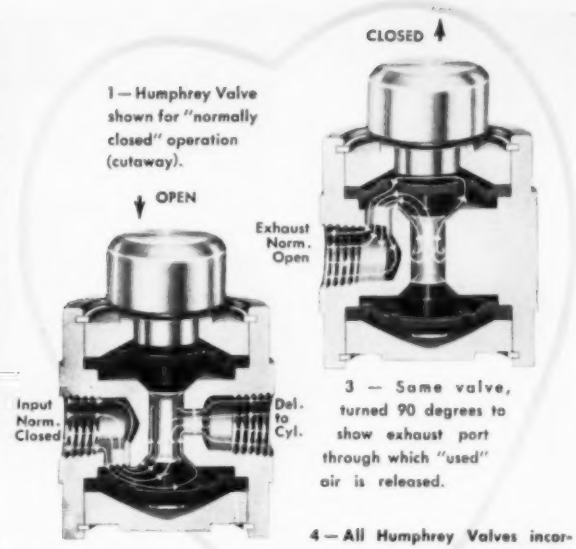
Circle **22** on Time-Saver Card



1 — Humphrey Valve shown for "normally closed" operation (cutaway).

2—In "open" position—(palm button depressed) air flows freely through wide ports into cylinder.

3 — Same valve, turned 90 degrees to show exhaust port through which "used" air is released.

4 — All Humphrey Valves incorporate this same principle—with choice of valve body styles for:

- **Exterior mounting**
- **Insert for manifold**
- **Manifold-mounted**

HUMPHREY "Quick-Dump" VALVES

OFFER *MORE* ON 2, 3, 4-WAY APPLICATIONS

- Pressures to 125 psi
- For Air, Gases, Water, Oil
- Dead Seal Shut-Off
- High Capacity Porting
- Cycling to 30,000/Hr.
- Extra Service Life
- **For Original Equipment and Plant Use**

ELECTRICALLY OPERATED

2-way and 3-way valves. Both one-coil "fail safe" and two-coil "momentary impulse" types.

MANUALLY OPERATED

2-way and 3-way finger-tip operation. A touch opens or closes. Many models — lever, cam, foot pedal, palm button, etc.

PILOT-OPERATED ELECTRIC VALVES

2-way and 3-way models, actuated by independent source of pressure. Two types: "fail safe" and "momentary impulse."

PILOT OPERATED VALVES

4-way 5-port shown (2, 3-way avail.) actuated by medium (gas or liquid) separate from medium being valved.

FULL ⅛", ¼", ½" CAPACITY THROUGHOUT — 42 MODELS

Basically simpler, faster-operating, longer-lived control valves. For temperatures from −65 to 225° F. Many exclusive, better features for superior performance. Adopted by nationally known O.E.M. firms.

Engineering assistance available on valving problems.

WRITE TODAY FOR BULLETIN 202-A

Humphrey Products

DIVISION OF GENERAL GAS LIGHT COMPANY

202 N. PARK ST., KALAMAZOO, MICHIGAN

Pneumatic-Hydraulic Valves and Devices

Circle **57** on Time-Saver Card

MEMO
Frank-
After the first couple of days, our V-rings don't seal worth a darn. Replacing them runs into money...and time. Is this necessary?
Charlie
MEMO
CHARLIE —
NO! R/M VEE-FLEX PACKING RINGS ARE DESIGNED TO PROVIDE AUTOMATIC SEALING ACTION OVER A LONG PERIOD OF TIME. SKETCH SHOWS HOW.
PLACE AN ORDER WITH R/M!
FRANK

Ordinary V-rings, with their flat surfaces, provide little or no automatic sealing action against the walls of the cylinder, with the result they quickly lose effectiveness. This means, of course, loss of power and eventually a maintenance problem. R/M Vee-Flex Packing Rings are specially designed to solve it for you. Convexly curved surfaces where the rings meet and thinner cross section at the apex of each V cause a flexing action which makes a firm seal on the shaft and stuffing box wall and between rings.

R/M Vee-Flex Rings are available in many compositions to meet the hazards of various applications: high temperatures, high pressures, fast cycling, corrosion, or combinations of these.

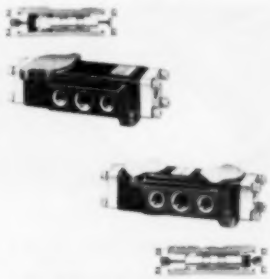
R/M's engineers have amassed a wealth of experience in manufacturing packings and gasket materials to meet the most exacting requirements of industry. This experience is at your disposal—call on R/M.

R/M
PACKINGS
RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, PASSAIC, N.J.
MECHANICAL PACKINGS AND GASKET MATERIALS

RAYBESTOS-MANHATTAN, INC., Mechanical Packings • Asbestos Textiles • Industrial Rubber • Engineered Plastics
Sintered Metal Products • Abrasive and Diamond Wheels • Rubber Covered Equipment • Brake Linings
Brake Blocks • Clutch Facings • Industrial Adhesives • Laundry Pads and Covers • Bowling Balls

NEW PRODUCTS

matic circuit. Fast operating response, compact and multi-million cycle life. Can be controlled electrically by solenoid pilots or pneumatically by manual valves.

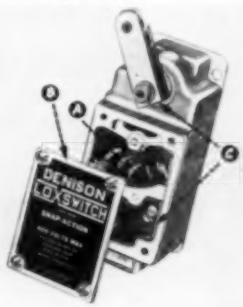


Specifications: Made in ¼-in single and double with integral junction box. Pressures to 250 psi. Air or oil service.

Valvair Corp.
Akron, Ohio
Circle **315** *on Time-Saver Card*

LIMIT SWITCHES . . . are watertight

Designation: Loxswitch
Features: Load carrying increased with 25% heavier silver contact bars. Heavy cover and seal make



switch oil, dust, and watertight. High dielectric housing insulator for arc resistance. Give 70 degree over-travel in both directions. Need only 125 inch ounce force to trip. Have 29 contact arrangements and over 150 lever styles.

R. B. Denison Mfg. Co.
Cleveland, Ohio
Circle **316** *on Time-Saver Card*

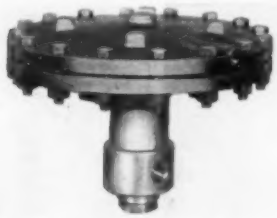
PRESSURE REDUCING VALVE . . . for 6000 psi

Designation: Type E

Features: Can be used for air, oil or gas. It uses a small air reducing valve in place of a spring, and a relief valve for charging the diaphragm chamber. This gives an

easy adjustment that can be made from a remote point.

Specifications: Trim is stainless steel with spindle and seat ring



stellited and wearing surfaces hard chrome plated and polished. Nylon seats are also available. Will reduce 6000 psi down to 100 psi in a single stage.

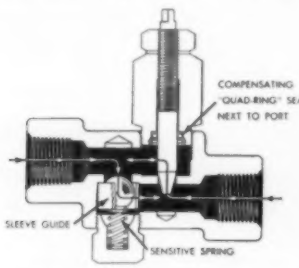
Atlas Valve Co.
Newark, N. J.

Circle **317** *on Time-Saver Card*

FLOW CONTROL VALVES . . . for air and oil

Designation: Model F

Features: Forged aluminum bodies. Large passages for low pressure drop. Vernier threaded needle for fine flow adjustment. Chatterless



ball check gives full flow in reverse direction. All internal parts made of stainless steel. Flow can be adjusted under full pressure.

Specifications: Made in pipe and tube sizes from ⅛ to ¾-inch for pressures to 3000 psi. Panel or in-line mounting.

Auto-Ponents, Inc.
Bellwood, Ill.

Circle **318** *on Time-Saver Card*

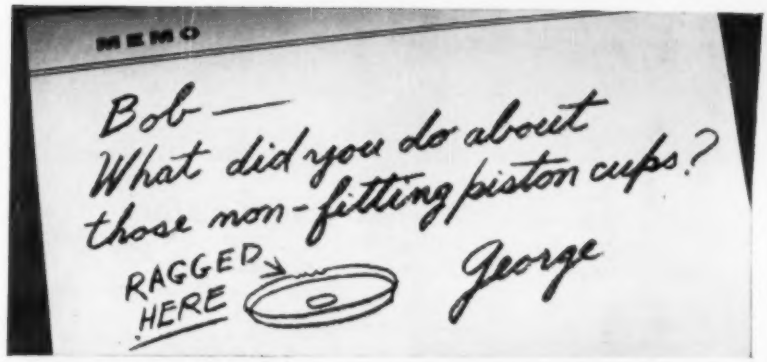
FLEXIBLE COUPLING . . . with one-piece Nylon sleeve

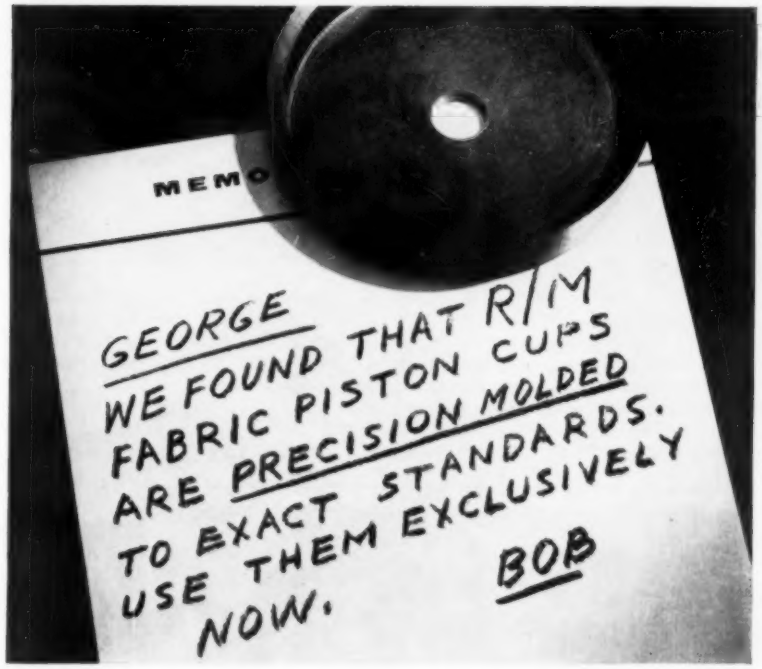
Designation: Nyflex

Features: Operates at high temperatures and speeds to 5000 rpm. Weighs 3½ lbs. Made in ten bore sizes from 7/16 to 1⅝-in. Priced lower than steel. Will operate with misalignment to 5 degrees. Ran for 800 hours at total misalignment with no sign of wear.

Sier-Bath Gear & Pump Co.
North Bergen, N. J.

Circle **319** *on Time-Saver Card*





You can be sure of minimum friction, long life, when you specify R/M Fabric Piston Cups. Molded of engineered synthetics with a variety of fabric reinforcements to suit your requirements. Superior resistance to extrusion.

Careful quality control at Raybestos-Manhattan makes a big difference you can see: clearly defined contours and cleanly trimmed edges. This is proof of dimensional uniformity, strict adherence to industry standard sizes. Your gain: maximum sealing efficiency.

R/M Fabric Piston Cups are made to fit hydraulic and pneumatic cylinders ranging in diameter from ½ to 12 in. Furnished in varying degrees of hardness for pressures up to 1500 psi and in different compounds to meet your specific operating conditions.

R/M's complete line of mechanical packings includes Vee-Flex Packings, Vee-Square Packings, Homogeneous V-rings, and Fabric Piston Cups. Write for complete information.

RM **PACKINGS**
RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, PASSAIC, N.J.
MECHANICAL PACKINGS AND GASKET MATERIALS

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Circle **91** *on Time-Saver Card*

NEW PRODUCTS

IN-LINE SOLENOID VALVE
. . . for 4,500 psi

Designation: Series V-27200

Features: Handle air, oil, or fuel. Internal parts made of Teflon and stainless steel. Shelf life is indefinite. Coil bobbin assembly is gas welded and coil is imbedded in high temperature epoxy resin.

Specifications: Orifice size .125-inch at 750 psi and .020-inch at 4,500 psi. Made in 2 and 3-way types for temperatures from —320 to 500 F. Response is 15 milliseconds. Voltage, 18 to 30 dc.

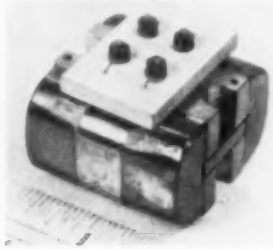
Valcor Engineering Corp.
Kenilworth, N. J.

Circle **320** *on Time-Saver Card*

TORQUE MOTOR
. . . for 600° F

Designation: Model 103-2

Features: For use in servovalves for high-speed aircraft or missiles. Needs no cooling system and has no thermal lag.



Specifications: Midposition force 8 lbs. Stroke ±.008 inches at a radius of .750 inches. Input 4 watts. Weight 10 ozs. Size 1⅛ x 1 11/16 x 1¾ inches.

American Measurement & Control, Inc.
Waltham 54, Mass.

Circle **321** *on Time-Saver Card*

OIL LINE FILTER
. . . with quick-change cartridge

Features: Made in 3 to 40 micron ratings. Element can be changed in less than a minute because of the

fliptop cap. Housing block has built-in, low-pressure, high-volume relief valve to protect filter element.

Specifications: Fliptop cap for working pressures to 250 psi. Bolted cap models for pressures to 2000 psi and flows to 150 gpm. Temperature rating 275 F.

Schroeder Brothers Corp.
McKees Rocks, Pa.

Circle **322** *on Time-Saver Card*

When the design calls for an indicating gauge, specify the best—
MARSH
How catalog covers gauges for every need
MARSH INSTRUMENT CO.
Sales Affiliate of Jas. P. Marsh Corporation
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8407 103rd Street, Edmonton, Alberta
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Circle **71** *on Time-Saver Card*

NEW STUD MOUNT 5/16" & 3/8" CYLINDERS!
Clippard Minimatic
MINIATURE AIR VALVES, CYLINDERS, SOLENOIDS, FITTINGS, ACCESSORIES
It's love at first sight when you discover how much smooth automatic power, without weight, you can pack in small spaces with NEW CLIPPARD MINIMATIC Air Cylinders, now available with stud, block, or clevis mountings. Industry's most COMPLETE line! Get details of our new 3/8" and 5/16" bore Cylinders — 52 standard models; 2, 3 and 4-way MINIATURE Air Valves, Quick-Connects and other products for AUTOMATED work set-ups or new end products. Life tested for millions of cycles of trouble-free operation!
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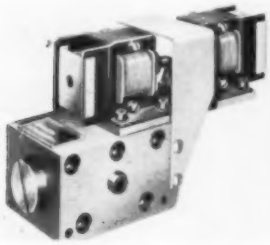
Manufacturers of Miniature Pneumatic Devices, R.F. Coils, Electronic Equipment

Circle **26** *on Time-Saver Card*

CONTROL VALVES
. . . have single or dual solenoids

Features: Precision built with electric furnace cast iron body and



hard nitraloy stem, ground and lapped. Continuous duty solenoids provide smooth shifting. Can be mounted horizontal or vertical.
Specifications: Capacity 3½ gpm at 1000 psi. Manifold or pipe tap. Size 8⅛ x 2⅜₁₆ x 4½ in.

John S. Barnes Corp.
Rockford, Ill.
Circle **323** *on Time-Saver Card*

SOLENOID VALVE
. . . is compact and low priced

Designation: Shorty
Features: Stainless steel pilot, unbreakable, stick-free piston rings and replaceable resilient seats. Pilot operated and can be held open with 5 psi pressure differential.
Specifications: Air pressures to 250 psi, water to 150 psi, and oil to 75 psi.

Atkomatic Valve Co., Inc.
Indianapolis, Ind.
Circle **324** *on Time-Saver Card*

AIR AND OIL CYLINDERS
. . . are all welded

Designation: HDI Series
Features: All steel construction. Molded wipers keep out abrasive materials. Heavy tube walls for high surge pressures. Single or double-acting.
Specifications: Hydraulic pressures

to 2000 psi and air to 200-psi. Bore sizes to 6-inch. Any stroke. For agriculture and industrial applications.

Unit Mfg. Co.
Minneapolis, Minn.
Circle **325** *on Time-Saver Card*

LOCTITE cuts rejects from 13% to 1/2% on Hamilton Standard Jet Fuel Controls!

The aluminum casting of this Hamilton Standard Jet Fuel Control contains 28 pipe plugs. The assembly is subjected to hydrostatic tests with JP-4 fuel at 1500 psi. With older type sealants, only one plug in 200 leaked—but that was far from good enough for Hamilton Standard. With 28 plugs in a casting, the reject rate on the test stand was 13%. Switching to LOCTITE Liquid Sealant, they have experienced only 23 leakers in over 124,000 plugs tested . . . a reject rate of ½%.

LOCTITE is a thin liquid which hardens when confined between closely-fitted metal parts and locks against vibration. It forms a tough, heat and oil-resistant bond completely filling the joint to insure a positive seal. Hardened LOCTITE is not affected by water, military fuels, hydraulic fluids, degreasing solvents and most chemicals. It has been successfully used to seal against Co_2, oxygen, Freon, nitrogen, acetylene and LPG. LOCTITE contains no solid particles and any excess outside the joint may be wiped off . . . there is no danger of residue entering fluid stream and fouling valve seats.

At Hamilton Standard, division of United Aircraft Corp., the plugs are first cleaned by dipping in activated solvent and air dried. A day's supply of clean plugs is treated with LOCTITE by tumbling in a plastic bag. The treated parts store until used in assembly since LOCTITE hardens only when confined.

Write for literature and free sample.

LOCTITE® SEALANT
AMERICAN SEALANTS COMPANY
153 Woodbine St., Hartford 6, Conn.
In Canada: J. S. Parkes & Co., Ltd., Montreal

Circle **8** *on Time-Saver Card*

Wagner now offers

AIR POWERED BRAKING SYSTEMS *for industry*

Now you can get air powered braking systems with the same dependable heavy duty brakes that Wagner has built for years for hydraulically operated overhead crane brakes. These systems offer unusual flexibility of application, since any number of brakes and control points may be used at any reasonable distance from each other.
Wagner application engineers can supply expert help in applying air power components for your specifications. Call your nearby Wagner branch.

W159-2

Wagner Electric Corporation
6387 PLYMOUTH AVE. • ST. LOUIS 14, MISSOURI
Circle **113** *on Time-Saver Card*

Circle 1 on Time-Saver Card

Fall . . . the original

SPRING-LOADED

Wiper **Ring**

This patented closed joint ring provides squeeze-grip action, assuring complete contact on the rod at all times. Maintains uniform, continuous pressure on wiper edge. Rods are always clean in any temperatures.

Fall "CJ" Wiper Rings operate most effectively under extreme conditions of dust, glaze, oil, grit, powder, gases, sand, ice, etc. Available in diameters ½" through 13". For any commercial use. Used by military and aviation industry since 1944.

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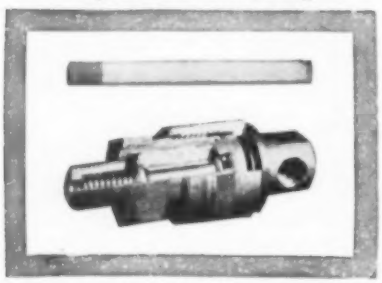
Est. 1935

NOW TRY HUSCO

Hydraulic Control-Engineering for improved Performance, —Space and Cost-Saving



Every Husco Hydraulic Control is custom-engineered for your equipment! We have no "standard" models to push. But our successful experience with hundreds of difficult control problems—confirmed by case histories—promises you the *right* control for your needs . . . Control Valves, Check Valves, Reciprocating Valves, Hydraulic Cylinders, Pumps, Power Units—they're all engineered to your specific equipment demands for size, capacity, performance. Check HUSCO *first* for precision engineered Hydraulic Units. You'll save time, money and worry. Write for details.

HUSCO HYDRAULIC UNIT SPECIALTIES CO.

Pumps • Valves • Cylinders

P. O. Box 257-A, Waukesha, Wis.

Circle 60 on Time-Saver Card

POST SCRIPTS OF INDUSTRY

News about people, manufacturers and sales organizations

Webster has new senior project engineer

Hipp

Webster Electric Company, Racine Wis., appointed William Hipp as the company's senior project engineer. A graduate of the University of Detroit College of Engineering, Hipp served for 19 years with Vickers, Inc., as field engineer and with Denison Engineering Div., American Brake Shoe Co., Rochester, N. Y. for four years. His new duties will be new product experimentations and research.

Parker-Hannifin adds distributors

Irving B. Moore Corp., Boston, Mass.; Louis H. Hein Company, Jersey City, N. J.; and J. N. Fauver Co., Inc., Cincinnati, Ohio, are newly franchised distributors for new seals manufactured by Parker Seal Company, Cleveland Ohio and Culver City, Calif. Ritter Engineering Co., Milwaukee, Wis., is now stocking hose and tube fittings, hydraulic check valves and piston-type accumulators.

Schroeder named general sales manager at Pesco

Schroeder

Formerly aircraft sales manager of Pesco Products Division, Borg - Warner Corp., Robert L. Schroeder has been promoted to general sales manager of the division at Bedford, Ohio. Schroeder started with Pesco in 1951, served as engineer, sales engineer, and assistant aircraft sales manager. He will now direct the entire Pesco sales organization including distributor sales and service.

Continued on page 130

American Brake Shoe builds new research center

Construction of a $2 million research center has begun on the grounds adjacent to the company's Denison Engineering Division in Columbus, Ohio. The 30,000 sq.ft. building will be known as the Denison Hydrodynamics Research Center of American Brake Shoe Company. Primary purpose of the center will be to expand current research activities and to launch advanced systems research in the fields of hydraulics, pneumatics and electronics. Projects will cover both industrial and military applications. Head of the operation will be Victor V. Blasutta, now vice president engineering, Denison Engineering Division. In addition to research facilities, the center will contain a machine shop for producing experimental parts, test cells for temperature and endurance testing, a metallurgical laboratory, a chemical laboratory and a technical library.

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AIR-MITE AIR CYLINDERS

Compact—
Powerful—
Rugged—
Low Cost!

AIR-MITE Cylinders—made in Single or Double Acting Series, in 4 mounting types, are high quality cylinders at a low price. Simple, rugged design and compact construction give them long life, permit easy mounting on jigs, fixtures, tools, or machines. Used wherever power holding, pushing, pulling, or lifting is required, AIR-MITE Cylinders will meet your most exacting requirements of dependability and long life. Write for complete catalog and prices.

QUALITY FEATURES:

1. Ground and polished steel ram
2. Brass, true-bore cylinders
3. High strength aluminum alloy cylinder heads
4. Bronze oilless ram bushing
5. Five steel tie rods

AIR-MITE DEVICES, INC.
4401 W. Kinzie St., Chicago 24, Ill.

NEW

SINGLE OR 2-SPOOL VALVE

MODEL WP

PARALLEL VALVE
for heavy duty industrial mobile hydraulic applications

GRESEN HYDRAULICS

Capacity: **40** GPM at 20 ft./sec.

MAX. PRESSURE: 1500 PSI

Features: **SPOOLS** – fully balanced, self centering, accurately feathered for fine metering action – separate ball checks for each spool.

CARTRIDGE type relief valve has hardened seat.

TRIPOD mounting feet for easy installation.

CHOICE of many modifications.

WRITE FOR LITERATURE

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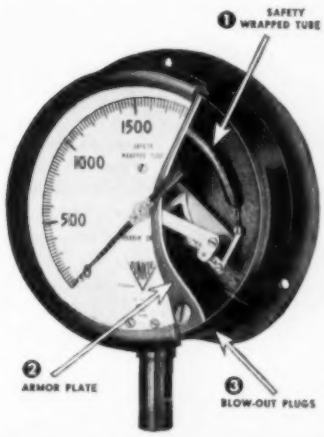
HI-RELIABILITY GAUGES NOW CATALOGED WITH SPEC. DATA FOR HYDRAULIC APPLICATIONS...

15 p.s.i., or 30" of vacuum, to 20,000 p.s.i., including the



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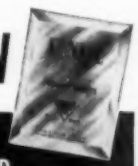

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Get longer bearing life by eliminating the transmission of shock and vibration from equipment to motor—use flexible couplings with drive inserts of Neoprene. These soft resilient inserts assure equal distribution of driving pressure, and are completely enclosed in the coupling halves. They insulate the coupling, require no lubrication. Find out all the advantages of using Magnaloy couplings. Write today for the Magnaloy Catalog.

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Series B

Series A
Attention Representatives

MAGNALOY

FLEXIBLE DRIVE COUPLINGS
PATENTS PENDING

Circle **33** on Time-Saver Card

POST SCRIPTS OF INDUSTRY

New appointments at Hydreco

Hydreco Division, The New York Air Brake Company, named Robert E. Schwary as manager of engineering and Robert F. Hodgson was appointed general sales manager. Schwary has been in the company's

Hodgson

Schwary

engineering department for the last seven years and since 1956 held the position of chief engineer - gear pumps and cylinders. Hodgson has been associated with Hydreco for 13 years and previously held the position of manager of engineering.

Robertshaw-Fulton names White

William H. White has become district sales manager for the Fulton Sylphon Division, Robertshaw-Fulton Controls Co., for the territory covering the upper half of New York State and northern counties of Pennsylvania. White's offices are located at 797 Military Rd., Buffalo, N.Y.

Kendall forms new corporation

Jules Kendall, announced formation of the Kenett Corporation, sales representatives and stocking distributors of hydraulic and pneumatic components. The new firm's headquarters are at 320 Washington Street, Brookline, Mass. The company will serve industrial and aircraft companies in the New York and New England areas for Greer Hydraulics, Inc., SC Hydraulic Engineering Co., Integral Corp., G & M Products Co.; Visiball Mfg. Co., RCH Mfg. Co., and Tycho Mfg. Co. A complete engineering staff is equipped to design special units, and handle industrial marketing surveys and analysis.

Schanzlin joins Tuthill

Schanzlin

Tuthill Pump Company, Chicago, Illinois, has named Ernest H. Schanzlin to direct all of Tuthill's research and engineering activities. Schanzlin was previously with Pesco Products Division, Borg Warner Corp., serving in many capacities, including chief engineer and assistant to the director of engineering.

New distributor appointments

Pneu-Hydraulics, Inc., Cleveland Ohio, will handle products made by Automatic Switch Company.

Abernathy-Thomas Engineering Co., Atlanta, Ga; Charlotte, N.C; Chattanooga, Kingsport, Knoxville, and Nashville Tenn.; Hare Equipment Co., Cincinnati, Ohio; Joseph C. Saraghan & Associates' Orlando, Florida office, will represent Ledeen Manufacturing Co. in their respective areas.

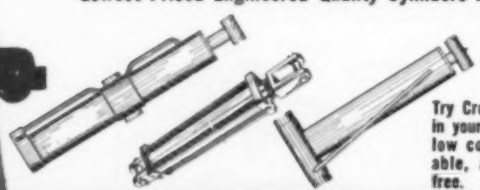
ON THE JOB...

with CROSS

HYDRAULIC CYLINDERS

Like Cross customers everywhere, you can stay "on the job" with dependable, rugged Cross Hydraulic cylinders. Cross, the trade-mark of quality in hydraulic cylinders, is as near as your phone. For fast delivery on any quantity, built to your specifications, contact Cross Engineering Department.

Lowest Priced Engineered Quality Cylinders Available



Try Cross Cylinders in your operation... low cost, dependable, and trouble free.

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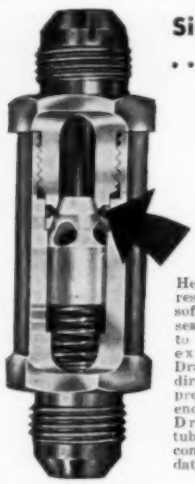

Simple, Secure ... Leak-Tight! this FLEXIBLE SEAL SEAT*

Here's the secret . . . responsive action of the soft, long-lasting O-ring seal! Instantly compresses to seal internal and external pressures. Draws harmlessly around dirt particles. No costly precision parts or extra end seals. Six standard Dryseal pipe and JIC tube sizes; 12 connection combinations. Send for data sheet.

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Kep-O-seal

HYDRAULIC & PNEUMATIC

CHECK VALVES

* PATENT APPLIED FOR

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SALES REPRESENTATIVES & DISTRIBUTORS FOR UNIQUE AUTOMATION CONTROL ITEM

Exclusive territories now all 49 states for outstanding new line of standardized linear control actuating devices. Offers unusual opportunity to reps now handling hydraulics and pneumatics lines, air cylinders. Numerous applications with your present customers and prospects. Approved as "standard" by many leading manufacturers. Helps reduce installation and manufacturing costs by at least 50%; slashes design time. In reply, state lines carried, area covered, experience. Linear Controls Co., 3400 Main St., Skokie, Ill.

WANTED—DESIGN ENGINEER

Well established, nationally known filter manufacturer needs an experienced design engineer, well versed in the field of hydraulics to aid in the design and development of new filters to broaden our present wide range of applications. Excellent opportunity for the right man to establish himself permanently with a progressive company. Remuneration commensurate with ability. Write giving full details of experience and background. Your reply will be held in strict confidence. Write Box 2459, APPLIED HYDRAULICS & PNEUMATICS.

HOSE ENGINEER WANTED

Hose engineer for hose coupling manufacturer in industrial and automotive fields. Recent graduate —Mechanical or Chemical Engineering—with knowledge of fluid flow and hydraulics. Address resume to The Weatherhead Company, 128 W. Washington Boulevard, Fort Wayne, Indiana.

SALES REPRESENTATIVES
Wanted By National Manufacturer of Hydraulic Equipment

Manufacturer of valves, special large bore cylinders, power units and pumps, wants representatives, experienced in the sale and application of such equipment, in the following areas: Memphis, Tennessee; Georgia; Florida; Louisiana; Fort Worth, Dallas and Houston; Virginia, North Carolina; and Denver, Colorado.
Write Box 2159, APPLIED HYDRAULICS & PNEUMATICS.

SALES ENGINEER

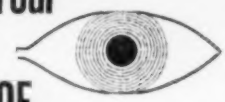
Over 15 years experience, service and application work on hydraulic components, wants affiliation with top notch hydraulic concern. Write Box 2359, APPLIED HYDRAULICS & PNEUMATICS.

FOR SALE

Vickers Pressure Relief Valves, Part Nos. CF-16-B, CF-16-C, CF-16-F.
Complete with flanges. Brand new —$80.00 each. Write to Box 2259, APPLIED HYDRAULICS & PNEUMATICS.

AIRCRAFT HYDRAULIC-PNEUMATIC ENGINEERS

Keep Your Eye On WALDROF



(or better yet, why not join us?)

Waldorf is the military products division of F. C. Huyck and Sons, a well known manufacturer of special engineered products for the paper industry.

We manufacture a line of fluid control devices for aircraft.

Occupying a new, fully air conditioned 65,000 square foot plant in Huntington, Long Island, Waldorf has the latest in precision manufacturing and quality control equipment.

In joining Waldorf you have the advantage of working in a small but growing organization where you will be recognized for **your individual** efforts, yet you have the additional advantage of having behind you the resources of a larger and rapidly growing industrial supplier with over eighty years of proven performance.

If you have the kind of experience which you feel qualifies you to become a member of our team, please write Walter S. White, Personnel Director, Waldorf Instrument Company, Huntington Station, L.I.

Candidates will be invited (expense paid) to our facility, and if the mutual decision is made that you will join us, you and your family will be relocated at our expense.

Incidentally, we are sure you will find our salary, bonus, and benefit arrangements attractive.

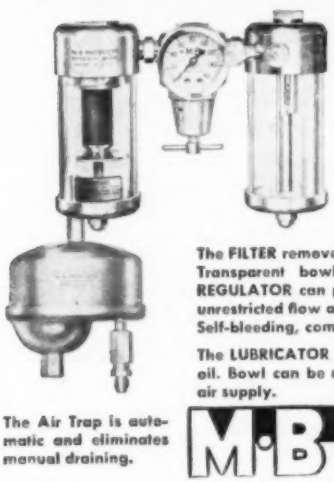
waldorf *fluid* SYSTEMS

■ Waldorf Instrument Co., Huntington Sta., N. Y.
■ A Division of F. C. Huyck & Sons, Inc.

GREATER PROTECTION to your AIR LINE!

M-B

WHIRL-A-WAY FILTER, REGULATOR AND LUBRICATOR ASSEMBLY AND AUTOMATIC AIR TRAP (MODEL W-4)



SUCCESSFULLY USED FOR PROTECTION OF AIR VALVES CYLINDERS CONTROLS PNEUMATIC TOOLS, ETC.

The FILTER removes solids .00039 and larger. Transparent bowl provides visibility. The REGULATOR can pass large volume with an unrestricted flow and minimum pressure drop. Self-bleeding, compact.

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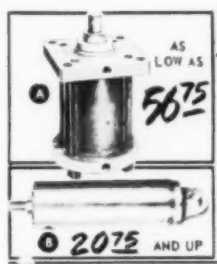

AS LOW AS 56.75

20.75 AND UP

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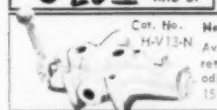
NEW PALLEY HYDRAULIC CYLINDERS – Here are two of our newly developed line of double action Industrial Hydraulic Cylinders. These cylinders are designed to meet the most rigid requirements of industry. All are heavy duty steel construction.

Type (A) is a heavy duty, cross type cylinder with bores of 3", 5", 6" and 8" – thrust range up to 75 TONS at 3000 PSI.

Type (B) is an internal cap type with bores of 1-1/2", 2", 2-1/2", 3", 3-1/2" and 4". Has strokes from 2" to 48". Delivers up to 18,850 lbs. thrust on 1500 PSI line pressure.

For complete listing of our tremendous stocks and prices – Send for our Special 196 Page Catalog TODAY



Cat. No. H-V13-N

Newly Developed 4-WAY, SLIDING PISTON VALVE Available in open or closed center types, with spring return or detents. Has built-in relief valve which is adjustable from 1200 to 3100 PSI. Allows flow up to 15 GPM at 3000 PSI. Only . . . $32.75

SURPLUS GOV'T BUYS

2000 PSI HYDRAULIC CYLINDER SPECIAL No. 66 12.75

Genuine top quality Gov't Surplus. Used but excellent condition. Has a Bore of 2-1/4", Shaft 1", Stroke 4", Eye-to-eye lgth. 13½", Ports 1/4" AN.

ELECT. HYDRAULIC MOTOR-PUMP AS LOW AS $115

Motor designed to face mount any Aircraft type hydraulic pump. For continuous duty with high starting torque. 115/230 V., 220/440 V., 1 and 3 phase, 60 cycle AC. Sizes from 3/4 to 15 HP. Pressure up to 3000 PSI. Further information in catalog below.

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Cat. No.	GPM	PSI	RPM	Price
H-P4A	5.3	1000	3000	$22.50*
H-P5A	2.7	1500	3000	25.75*
H-P4U	4.	1000	3000	22.50*

*Used but excellent condition.

STRATO POWER PUMP BARGAIN! Delivers 10 GPM at 1500 RPM at 3000 PSI. Cost Gov't approx. $1200 – Cat. No. P-30-D – Now Only $ 125.00

HYDRAULIC TEST STANDS – Available now at remarkable savings. Write for info.

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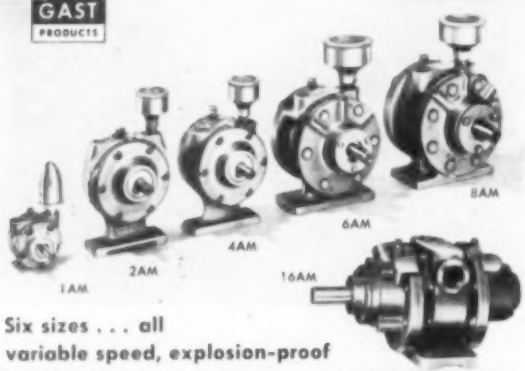
ROTARY AIR
GAST
PRODUCTS



Six sizes . . . all
variable speed, explosion-proof

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1. Explosion-proof power. No danger!
2. Low initial cost per rated h.p.
3. Variable speed with valve control.
4. Can't burn out from overloads.
5. Vanes take up their own wear.
6. Reversible rotation (opt.) 5 sizes.
7. Very compact — light in weight.
8. Top-quality ball-bearing design.

TYPICAL PERFORMANCE		
Model No.	H.P. at 90 PSI 2000 RPM	Weight lbs.
1AM	0.13	1½
2AM	0.57	5½
4AM	1.1	8
6AM	2.0	17
8AM	4.0	25
16AM	7.0	65

Gast Manufacturing Corp.
P.O. Box 117-D
Benton Harbor, Mich.

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"Air may be your answer!"
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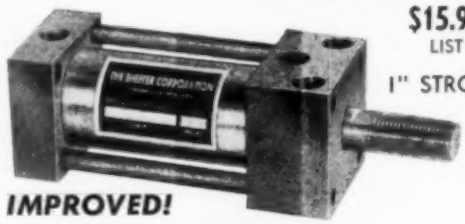

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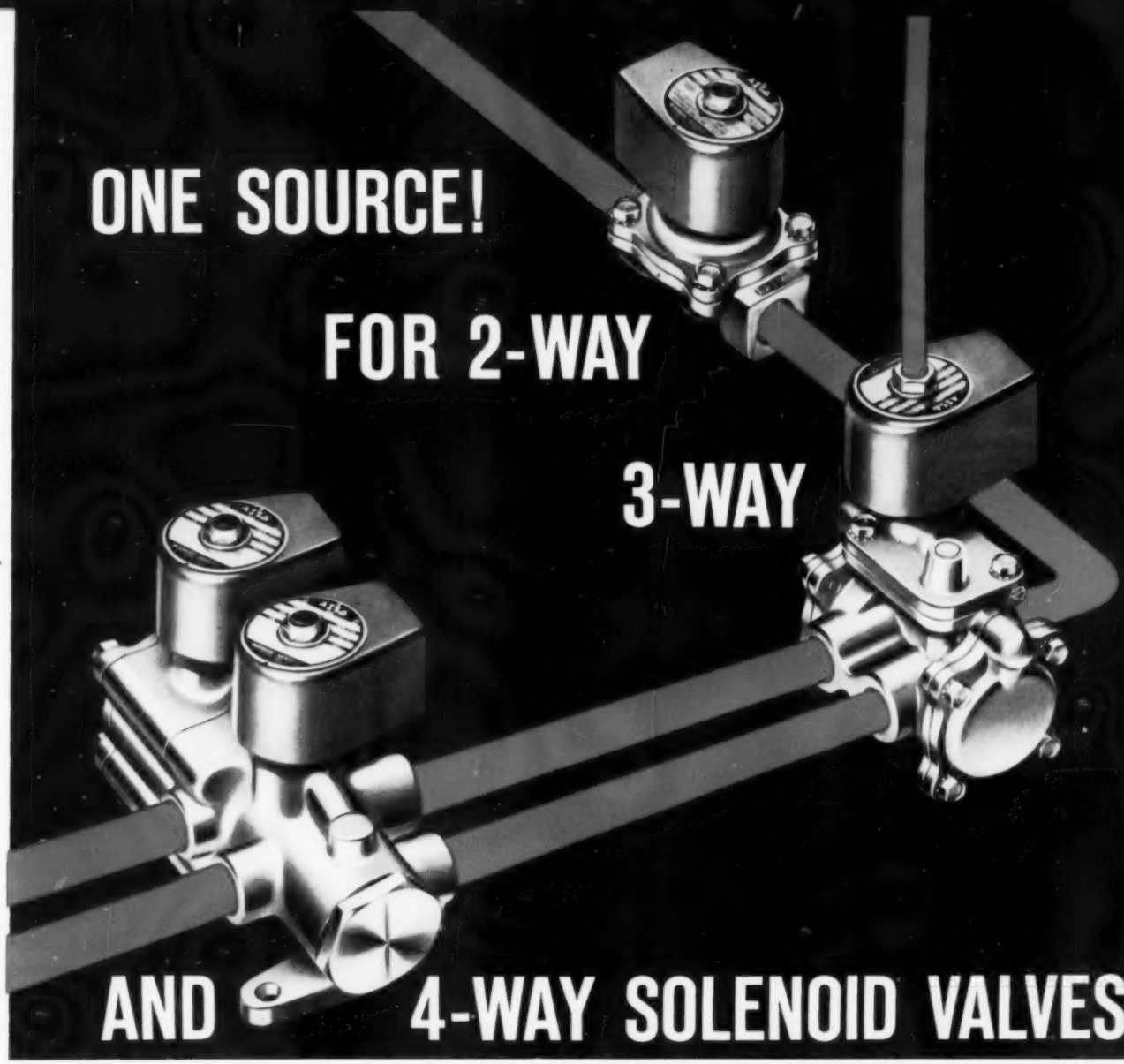

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Jones suffered a heart attack. It happens to hundreds of thousands of Americans each year. Heart attack, or coronary artery disease, is our nation's leading single cause of death, accounting for 250,000 fatalities annually.

But because of new advances in diagnosis and treatment, *most victims of heart attack recover* to lead useful and productive lives.

Jones recovered and is back at his desk today, thanks to new medical knowledge developed through heart research.

Your Heart Association, through *your* support of the Heart Fund, has allocated more than $32 million during the past ten years to research on heart and circulatory diseases. A large portion is being spent to discover the underlying causes of atherosclerosis, a form of hardening of the arteries, which is responsible for heart attack.

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